Winter 12-29-2016

Exploring Knowledge, Beliefs and Practices of Radon Gas Exposure Among Public Health Workers

Paschal Nwako
paschal.nwako@student.shu.edu

Exploring Knowledge, Beliefs and Practices of Radon Gas Exposure Among Public Health Workers

by

Paschal Nwako

Submitted in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

School of Health and Medical Sciences

Seton Hall University

Exploring knowledge, beliefs and practices of radon gas exposure among public health workers

by

Paschal Nwako

Dissertation Committee:

Terrence F. Cahill, Ed.D., FACHE
Michelle D'Abundo, PhD, MSH, CHES
Ning Jackie Zhang, MD, PhD, MPH

Approved by the Dissertation Committee:

Terrence F Cahill Date 12/14/16

Michelle D'Abundo Date 12/14/16

Date 12/14/16

Submitted in partial fulfillment of the requirements for the degree of
Doctor of Philosophy
School of Health and Medical Sciences
Seton Hall University

ACKNOWLEDGEMENTS

I would like to first thank God for life and guidance through the difficult years spent going through my academic journey at Seton Hall. I am indebted and grateful to Dr. Cahill that believed in me against all odds. The mentorship, guidance, and support provided by my dissertation committee were invaluable. Thank you, Dr. Zhang for your support and insights into the bigger picture about this project. Thank you also Dr. D'Abundo for your planned criticisms and working with me at the beginning to format my scale through the panel of experts. To my dissertation committee members, it was a lesson to learn how to listen and grasp your different ways of reasoning in other to come up with an agreeable consensus on how to proceed at different stages of this project. I thank each of you for your unique contributions, not only to this project, but to my scholarly development and personal growth.

During my academic journey, I lost two of my relatives. My mum Elizabeth and a year later my brother Cyril Jnr, who received his PhD from NYU. Life and its meaning changed for me. Their influence in addition to my father Late Sir Cyril Sr. and the family tradition of searching for higher learning made me continue with this journey to the end against all odds. Dad and mum, I dedicate this to you.

Finally, I want to thank my family members in general around the world for their patience with me through this academic process. I cannot end this without immensely thanking Madonna my wife of 24 years. She has been on by my side through thick and thin. She kept her academic enhancement on hold waiting for me to accomplish mine. I thank my four children for putting up with my consistent no shows and short attention span. You light up my world.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Radon gas exposure is the highest cause of lung cancer among people that never smoked in the United States. People exposed to elevated levels of radon had a higher risk of developing lung cancer. Achieving the long term goal of the Indoor Radon Abatement Act (IRAA) of 1988 require a combined efforts of government agencies. Public health workers are change agents and their role in protecting and improving the health of their communities are well documented. This study created and utilized a multi question survey, the Public Health Workers Radon Assessment Instrument (PHWRAI) to explore knowledge, beliefs, personal and professional practices about radon exposure among public health workers. This study found significant differences in professional practices, knowledge, beliefs and personal practices about radon gas exposure among public health workers. This study also found significant relationships between knowledge and professional practices; knowledge and personal practices; beliefs and professional practices; personal and professional practices about radon gas exposure among public health workers. Further, the study found that even though public health workers had knowledge and beliefs about radon gas exposure, it did not translate into personal practices of protecting themselves and their families from radon gas exposure or professional practices of informing, educating and creating awareness in the public about radon gas exposure as part of their job responsibility. These findings suggest that the role of public health workers in disseminating environmental hazards to the communities they serve should be well-defined and be part of a strategy to be in compliance with the IRAA of 1988.

Keywords and phrases: radon gas, public health workers, knowledge, beliefs, personal practices, professional practices.

Chapter I

INTRODUCTION

Background

Radon is a radioactive, invisible, odorless and tasteless naturally occurring gas produced by the breakdown of uranium in soil, rock and water (United States Environmental Protection Agency [USEPA], 2012). Approximately one out of every fifteen homes in the U.S. was estimated to have elevated radon levels (USEPA, 2012). Radioactive particles from radon decay can be trapped in the lungs, where they damage lung tissue and may lead to lung cancer. The risk of developing lung cancer from radon exposure depends on (1) the measure of radon in the home (dose), (2) the amount of time spent in the home (duration), and (3) smoking status of individual exposed (host factor). Radon gas is found naturally in rocks and soils. When radon gas is found in spaces such as basements and lower levels of homes through cracks and openings in walls and foundations, the radon gas builds up to high concentrations and is harmful to the lungs of individuals living in those spaces (Al Zabadi et al., 2012; USEPA, 2011; USEPA, 2012).

Radon gas primary routes to potential human exposure are inhalation radon gas and ingestion of water-dissolved radon. Radon gas source from well water may be released into the air when water is used for showering and other household uses. Research suggests that radon gas in drinking water may also pose risks to humans, but this risk is much lower than risks associated with breathing radon gas (Al Zabadi et al., 2012; USEPA, 2012). The USEPA (2012) estimated that radon gas is responsible for about 21,000 deaths each year in the United States.

Testing for radon gas exposure is the only way to determine if a home has an elevated radon level.

A study conducted on the relationship between radon gas and lung cancer was first established in miners (National Research Council [NRC] BEIR IV 1988; NRC BEIR, 1999). The USEPA (2012) and Field (2010) reported that among people who have never smoked, radon is the leading cause of lung cancer in the United States. Radon is the second cause of lung cancer among smokers. The International Agency for Research on Cancer (1988) declared radon gas a human carcinogen. Previous studies have reported that exposure to average levels of radon gas in combination with smoking, increases the smoker's risk of lung cancer at least ten fold (NRC BEIR, 1999; Reif & Heeran, 1999). Mendez et al. (2011) reported that based on the USEPA radon level of 4 pCi/L, the lifetime risk of radon induced lung cancer death is 62 per 100 for ever smokers and 7 per 100 for never smokers. Hence a smoker is 8.86 times more likely to develop lung cancer if exposed to radon gas than nonsmokers. The USEPA (2012) and the U.S. Surgeon General (USEPA, 2005) recommend testing all homes in the U.S. below the third floor for radon. There are many kinds of low-cost radon test kits that homeowners can purchase in hardware stores and other retail outlets across the United States. The state radon offices also provide a list of trained contractors who conducts these tests.

Public health workers are essentially people whose job is to protect and improve the health of their communities and engage in actions with the primary intention of enhancing health (World Health Organization [WHO], 2006). Public health workers are primarily change agents and their role in influencing the public perception and attitude toward health risk factors are well documented (Abrams & Hays, 2006; Cohrssen & Covello, 1989; Institute of Medicine

[IOM], 1988; WHO, 2006). Public health workers daily come in contact with patients and members of the public (WHO, 2006). The IOM (1988) report commented that public health workers and their agencies serve as stewards of the basic healthcare needs of the entire U.S. population especially those rejected by the rest of the health care system. Public health workers can be used as agents of change and act as risk communicators to the public utilizing their vast knowledge of risks to radon gas exposure (WHO, 2009).

Problem Statement

On January 13th, 2005, the U.S. Surgeon General Richard Carmona issued a health advisory on indoor radon gas exposure. The Surgeon General acknowledged that radon gas is the second-leading cause of lung cancer in the United States and that breathing radon gas over an extended period of time can present a significant health risk. He further stressed that the threat to radon gas is completely preventable with a simple test and that radon sources can be corrected through established venting techniques. The USEPA (2008) reported that the U.S. Congress in 1988 established the Indoor Radon Abatement Act (IRAA), which requires air within buildings in the United States to be as free of radon as the ambient air outside of buildings. Traditionally radon gas testing is not mandatory in the United States. The USEPA is not enforcing the IRAA but has only administered a voluntary program to reduce exposure to indoor radon by promoting testing, awareness, installation of radon mitigating systems in existing homes and use of radon resistant new construction techniques (USEPA, 2008). Much of the progress made in reducing radon gas exposure has occurred as a result of real estate transactions (USEPA, 2008). Apart from homebuyers that sometimes are required to have

homes tested before closing, homeowners may or may not choose to adopt risk reduction activities to minimize or prevent radon gas exposures (Hill, Butter & Larsson, 2006). According to USEPA (2011), most radon measurements in the U.S. are voluntarily made by homeowners using charcoal canister detectors. In a typical case, a single detector is exposed from two to four days under enclosed house conditions in the lowest living level of a home. This screening test is used as a diagnostic tool to decide what action, if any, to take to reduce radon gas exposure. If the radon test result is 4 pCi/L (or above), the homeowner is directed to act, by conducting a second screening. If the average of the two screening tests is 4 pCi/L (or above), then the homeowner is advised to fix their home (USEPA, 2011). The USEPA have set the level at 4 pCi/L but recommends taking action at levels as low as 2 pCi/L (USEPA, 2011). The WHO (2006) stated that since DNA damage may occur at any levels of exposure, no threshold value for radon exists. This further suggests that indoor residential radon concentration should be reduced to the lowest possible level (Turner et al., 2011).

Need for the Study

From previous studies, it has been established that Americans spend about 90% of their time indoors (Hancock, 2002; Klepeis, Tsang & Behar, 1996; Klepeis et al., 2001; Ott, 1989). Despite the well documented and direct link between radon gas and lung cancer, the general public knowledge and attitudes of risk perception to radon exposure has not been entirely addressed by the regulatory authorities (Hancock, 2002). The USEPA Inspector General Report of June 3rd, 2008, confirmed that radon exposure gets worse each year. The USEPA understands and agrees that the radon program is not achieving results and that the IRAA goal is not

achievable, but refused to notify United States Congress that the goal set by statute in 1988 is unachievable (USEPA, 2008). The USEPA Inspector General recommended that USEPA develop a strategy for achieving the long-term goal of the IRAA or explain an alternative strategy to prevent an annual increase in radon gas exposure in the United States (USEPA, 2008).

Curriculum for some public health workers training covers radon gas as a radioactive material from an occupational health and safety perspective, rather than an environmental pollutant found in homes. Many surveys have been performed on public health workers serving as risk communicators. These include public health workers (Shlafer, McRee, Gower & Bearinger, 2016) physicians (Trasande et al., 2006; Trasande et al., 2010); nurses (Abrams & Hays, 2006; Dixon et al., 2009; IOM, 1995) and pharmacists (Odedina et al., 2008; Simmons-Yon et al., 2012). These surveys found that public health workers would be better prepared to serve as risk communicators to the general public if they have a knowledge of radon gas as a health hazard. These studies consistently identified significant gaps in knowledge about environmental hazards among public health workers, highlighting that while in training healthcare workers did not have an appropriate knowledge of environmental health effects from radon and other environmental pollutants, hence they were not prepared to communicate with the public regarding environmental hazards such as radon gas exposure. Communicating effectively about risk with the public and the media has an essential role within the public health system (Fitzpatrick-Lewis et al., 2010; ATSDR CDC, 2008). Risk communication research literature is vast and diverse cutting across and including many results from different disciplines and applications. Effective communication has been found to be part of the risk analysis process and viewed as essential for controlling of information and belief related to real

and perceived hazards (Food & Agriculture Organization [FAO], 1995). However, it is vital to notify the public in methods that do not create unnecessary apathy, overconfidence or contentment while not creating undue stress or alarm (ATSDR CDC, 2008). Effective information dissemination approaches are essential for eliciting desired outcomes, whether increased awareness or attitudinal or behavioral change (Bier, 2001). Providing useful, relevant and accurate information in a clear and understandable language and format for a particular audience or risk group is an underlying goal of risk communication. This information may include the nature of the risk and potential benefits, uncertainties, rationale for action and strategies for managing risk (Fitzpatrick-Lewis et al., 2010)

Purpose of the study

The purpose of the study is to explore potential differences in various public health workers knowledge, beliefs, personal and professional practices about radon gas exposure. Furthermore, this study will explore if public health worker's knowledge and beliefs are related to their personal and professional practices regarding radon gas exposure.

The government agencies at the federal, state, county and local jurisdictions have a major role in disseminating the potential risk of radon to the public. The USEPA position requiring prevention of radon in homes through public awareness about radon gas exposure is not clear and fully addressed. The USEPA has administered a voluntary program to reduce exposure to indoor radon gas exposure in the United States (USEPA, 2008). Public health workers working in public health departments have been identified as an essential component of a radon risk communication campaign. They can be used as change agents to disseminate

information regarding radon hazards to the public (WHO, 2009; WHO, 2006). Presently, there exists no evidence of a direct measure of knowledge, beliefs, personal and professional practices to radon gas exposure among public health workers. Prevention of diseases and maintenance of health is a central role played by human behavior (Baban & Craciu, 2007). The awareness of naturally occurring environmental hazards such as radon gas need greater knowledge in the public, however, the agency entrusted to create radon awareness in the public and enforce the IRAA of 1988 has no clear agenda in achieving the goal of the IRAA (USEPA, 2008).

Public health workers are essentially people whose job is to protect and improve the health of their communities and engage in actions with the primary intention of enhancing health (WHO, 2006). Public health workers are stewards of addressing health care needs especially those rejected by the rest of the system (IOM, 1988). Public Health Department workers are members of the United States public health workforce (National Association of City and County Health Officials [NACCHO], 2013). Public Health Department workers have a special significance because as government workers, they are in the frontline for the implementation of many essential public health services in the face of changing communities' expectations and threats to the public health (NACCHO, 2013). There are many professions in the field of public health namely, Public Health Officers, Registered Nurses, Pharmacists, Physicians, Licensed Practical nurses, Registered Environmental Health Specialists, Epidemiologists, Health Educators, Nutritionists, Nursing Practitioners, Public Health Investigators and Veterinarians.

For public health workers to communicate risks associated with radon exposure and advocate home testing to the public, they must have a knowledge of hazards to radon gas

exposure. Thus far there have been no studies showing the knowledge, beliefs, personal and professional practices about radon gas exposure among public health workers. Having the answers to these issues will provide regulatory authorities with evidence to inform their strategies about using public health workers in disseminating radon gas awareness to the public. Furthermore, this study may provide baseline information that could be used to determine if practicing public health professionals need in-service training geared towards environmental hazards especially radon gas.

Research Questions

For the purpose of this study, the research questions are:

- RQ1a. Is there a difference in professional practices about radon gas exposure among public health workers?
- RQ1b. Is there a relationship between professional practices and knowledge about radon gas exposure among public health workers?
- RQ2a. Is there a difference in knowledge about radon gas exposure among public health workers?
- RQ 2b. Is there a relationship between knowledge and personal practices about radon gas among public health workers?
- RQ 3a. Is there a difference in beliefs about radon gas exposure among public health workers?
- RQ 3b. Is there a relationship between public health worker's beliefs and their professional practices about radon gas exposure?

- RQ 4a. Is there a difference in personal practices about radon gas exposure among public health workers?
- RQ 4b. Is there a relationship between public health worker's personal practices and their professional practices about radon gas exposure?

Research Hypotheses

The hypotheses were derived from the research questions, and they are as follows:

- H1a: There are significant differences in professional practices about radon gas exposure among public health workers.
- H1b: There are significant relationships between professional practices and knowledge about radon gas among public health workers.
- H2a: There are significant differences in knowledge about radon gas exposure among public health workers.
- H2b: There are significant relationships between knowledge and personal practices about radon gas among public health workers.
- H3a: There are significant differences in beliefs about radon gas exposure among public health workers.
- H3b: There are significant relationships between public health worker's beliefs and their professional practices about radon gas exposure.
- H4a: There are significant differences in personal practices about radon gas exposure among public health workers.

- H4b: There are significant relationships between public health worker's personal practices and their professional practices about radon gas exposure.

Conceptual Framework

There have been many different theoretical frameworks used to describe the ways in which people construct and express their beliefs (perceptions) and attitudes, which can translate into personal and professional practices. These theories have identified two broad categories of processes by which attitudes are expressed, namely top-down and bottom-up processing of information (Van Der Pligt et al., 2000). Our daily behavioral choices are usually guided by habit, impulse, or rule. In such cases, an attitude is expressed through a mostly automatic top-down process (Van Harreveld & Van Der Pligt, 2004; Van Harreveld, Van Der Pligt, De Vries, Wenneker & Verhue, 2004). In other cases, Fazio (2007) reported that people must engage in the bottom- up processing, because automatic top-down processes have failed to produce an immediate judgment. This process occurs when there is relevant information in memory, and people use bottom-up processes to construct attitudes by weighing the relevance of available salient beliefs (Lindell & Perry, 1991). Van Harreveld and Van der Pligt (2004) showed that people were particularly likely to engage in bottom-up processing when they regard an issue as personally relevant or when they are more involved in that matter.

Bottom-up processing of information is central to persuasive arguments theory (PAT). The PAT explains how shifts in choices, attitudes, and perceptions occur after group discussion (Eagly & Chaiken, 1993; Isenberg, 1986; Prislin &Wood, 2005). PAT asserts that individuals recall pro and con arguments from memory and that the number and persuasiveness of recalled arguments determine how individuals formulate their positions (Terpstra, Lindell & Gutteling,

2009). Furthermore, Terpstra, Lindell & Gutteling (2009) reported that attitude shifts that are relevant, valid and novel occur during group discussions. These attitude shifts are perceived to be valid and happen when they are consistent with other arguments freshly presented or with a person's existing beliefs. Consequently, arguments are seen to be novel when they present new information or new implications of existing information (Terpstra, Lindell & Gutteling, 2009). Petty & Krosnick (1995) reported that attitudes that are more persistent to change over time are more likely to cause biases in information processing. However, in contrast, people who hold neutral attitudes of neither positive nor negative are equally receptive to information supporting or discrediting a position (Thompson, Zanna & Griffin, 1995). This attitude shift means that when people have equal amounts of positive and negative information (or virtually no information); an attitude may be easy to change (Petty & Krosnick, 1995).

There are two primary mechanisms of attitude change that seem to be particularly relevant to risk communication programs. They are direct personal experience and vicarious experience produced by social communication (Lindell & Perry, 2004). Direct behavioral experience has a greater potential than vicarious or indirect experiences. This is because attitudes based on direct experience are more accessible in memory (Fazio & Zanna, 1981; Glassman & Albarracin, 2006; Petty, Wheeler & Tormala, 2003; Regan & Fazio, 1977). Weinstein (1989) found that personal hazard experience increases protection motivation, provides greater vividness and detail of hazard information. Furthermore, personal hazard experiences also increase rapid recall of relevant information, greater personal involvement, and lower levels of uncertainty (Weinstein, 1989). Studies have shown that enhanced protection motivation causes people to give more attention to relevant information, stimulate

the collection of more information, making people more likely to adopt hazard adjustments that will protect them and their property (Lindell & Prater, 2002; Terpstra, Lindell & Gutteling, 2009). This theory appears relevant for public health agencies to create awareness in the public about hazards to radon gas exposure.

Terpstra, Lindell & Gutteling (2009) reported that personal experience with hazard adjustments increases adoption intentions by providing more rich and detailed information and lower levels of uncertainty. Vicarious experience with either a hazard or hazard adjustments can also affect people's protection motivation and hazard adjustment adoption in the same ways as direct experience (Lindell & Prater, 2002; Terpstra, Lindell & Gutteling, 2009). Terpstra, Lindell & Gutteling (2009) indicated that the principal difference is that vicarious experience is not as vivid, easily recalled, or personally involving. Thus, it is unlikely to increase protection motivation or produce hazard adjustment adoption.

Nearly all theoretical models in health psychology employ cognitive constructs. For example, Stage theories (Prochaska & DiClemente, 1983; Weinstein, Sandman & Blalock, 2008; Weinstein & Sandman, 1992b) are relatively easy to demonstrate the degree to which cognitive constructs have been incorporated into the prediction of health behaviors. The idea distinguishes stage theories that the determinants of movement toward a health behaviors vary from stage to stage. Clark et al. (2002) applied stage theory to mammography screening, which exemplifies this approach.

The influence of cognitive approaches to understanding and promoting health behaviors are not unique to the study of mammogram acceptance. Strong cognitive influences are fcators that contribute to producing a result, can also be seen in many health related research.

Available studies include home radon testing (Weinstein, Lyon, Sandman, & Cuite, 1998), teen smoking (Plummer et al., 2001), and obesity (Sarkin, Johnson, Prochaska, & Prochaska, 2001). Other studies include condom use (Fisher, Fisher, Bryan, & Misovich, 2002), and drinking problem (Migneault, Velicer, Prochaska, & Stevenson, 1999). In each case, cognitive factors are central to the prediction of behavior and are identified as intervention targets to promote subsequent health-behavior change.

The idea of a conceptual frame is that the theory explains what the study expects to find. It is used to make theoritical distinctions and organizes ideas, concepts, assumptions, expectations and beliefs that supports and informs a study. This study slelected to use Precaution Adoption Process Model as it is proposed to better explain the process of the study. Precaution Adoption Process Model ("PAPM") is a stage theory originally developed to describe the process by which people adopt precaution to what they recently learned, rather than information they have been aware of for some time (Weinstein, 1988). PAPM seeks to identify all stages that are involved when people start a health behavior and what factors determine their movement from one stage to another before they act or change a behavior or make a health decision. PAPM attempts to explain a person's decisions process until that person takes action and translates that decision into action. PAPM adoption of a new precaution or cessation of a risky behavior requires deliberate steps unlikely to occur outside of conscious awareness (Weinstein, Sandman & Blalock, 2008). PAPM applies not to habitual behavior but to actions taken to reach a decision.

PAPM has several advantages. First, it allows for tailoring of messages for each stage. Second, it requires only a single question to assess a person's stage. This makes PAPM suitable for use in individual as well as group settings (Weinstein & Sandman, 2002; Weinstein, Sandman & Blalcok, 2008). Third, PAPM is a particularly useful tool when behavior change is difficult and resistance to change is high (Weinstein & Sandman, 2002; Weinstein, Sandman & Blalcok, 2008). In such situations having separate messages for each PAPM stage is quite useful. Figure 1 in a nut shell PAPM explains how a person comes to decision to take action and how it translates that decision into action. The stages are designed to classify people according to their current status with respect to deciding about the behavior they can adopt.

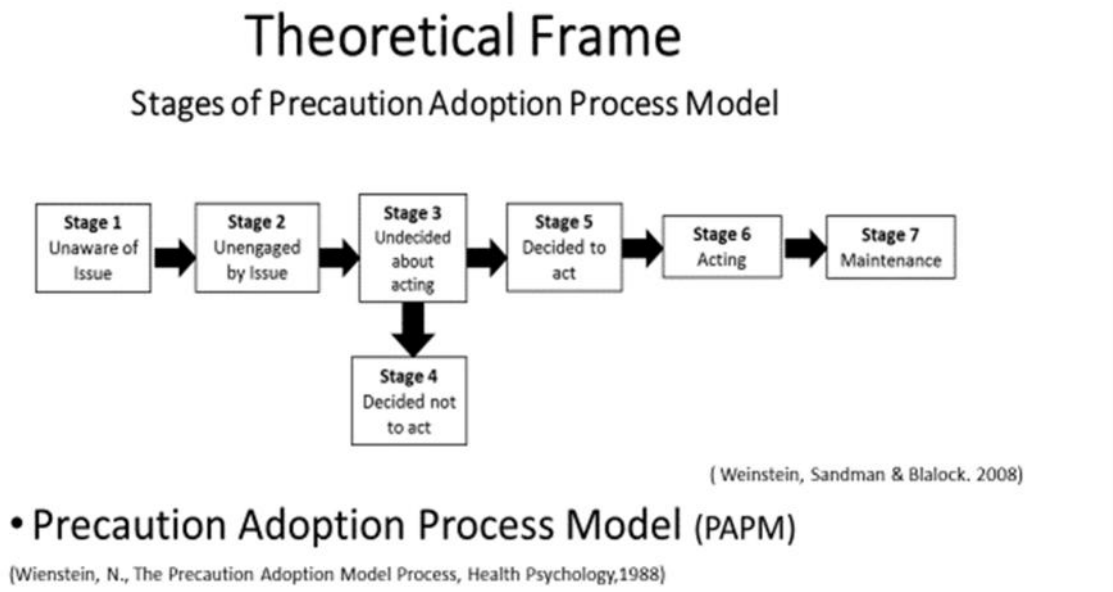

Figure 1. Stages of Precaution Adoption Process Model

The next chapter will explore the literature on radon gas exposure, problem with radon gas, risk perception, public health workers practice as risk communicators (nurses, pharmacists,

physicians, health educators, and registered environmental health specialists), public health workers radon training and communicating radon risk to the public.

Chapter II

LITERATURE REVIEW

Introduction, the Problem with Radon

Radon gas makes its way into houses from the ground below through cracks in foundations and other openings, such as floor drains and pores in cinderblock walls. The concentrations of radon gas in houses depend on the strength of the radon source on the ground, and the rate of air exchange (USEPA, 2012). Attempts to increase energy efficiency have reduced this exchange, trapping more radon inside the house. Duckworth (2002) reported that the development of airtight, highly insulated structures had promoted conditions that favor the buildup of radon in these structures. Many homeowners use the air conditioner and central heating especially in new homes built after the 1980s that have higher levels of insulation and constructed more tightly than those built earlier. Even though these new home equipment conserve energy, and require the closing of windows and doors, they reduce indoor air circulation and ventilation (Duckworth, 2002). However, some houses have cracks in their foundations and inside walls. Some have gaps around utility pipes, sump pumps and suspended floors, where radon gas can enter and accumulate (Duckworth, 2002). The health risks from radon depend on the concentration and the extent of exposure (Desvousges, Smith & Rink, 1992). Reports have shown that radon-induced lung cancers occur from low and medium dose exposures in homes (WHO, 2009; USEPA, 2012). Fleisher et al. (1980) found that the level of radon on the first floor of a home might be less than half of the level in the basement. However, studies in Europe, North America, and China have confirmed that lower concentrations of radon, such as found in homes, similarly confer health risks and contribute

substantially to the occurrence of lung cancer worldwide (Darby, 2005; Krewski et al., 2005 & Lubin et al., 2005). DeAscentis & Graham (1998) reported that according to the Havard Center for Risk Analysis, the inhalation of radon gas ranked as the most important potentially fatal hazard in the home. They estimated the annual cause-specific mortality rate to be 5.8 per 100,000 people.

Cigarette smoking in combination with radon gas exposure plays an enormous role in the development of lung cancer. This synergistic effect of smoking and radon gas exposure has been widely reported. It is estimated that exposure to radon gas in combination with smoking increases the smoker's risk of lung cancer at least ten-fold (Beir, 1999; Reif & Haeeran, 1999). Hampson et al. (2006) performed a study of smoking and radon; perceived traits, perceived risks and risk reduction behaviors. They found that moderating effects of personality traits should be considered when evaluating risk-reduction interventions. In all, cigarette smoking and radon gas exposure is a potentially catastrophic combination. Evaluating the smoking status of public health workers in relation to their potential exposure to radon gas is part of this study.

The concentration of radon gas in groundwater or building materials enters the working area or living spaces and disintegrates into its decay products. Although elevated levels of radon gas in groundwater may contribute to radon gas exposure through ingestion, the exposure risk through inhalation of radon gas released from water is usually more significant (Al Zabadi et al., 2012). Radon Polonium-218 (Po-218) and Polonium-214 (Po-214), which emit highly analyzing particles, can interact with the biological tissue in the lungs when radon gas is

inhaled and can lead to DNA damage that is reflected as a significant step in the carcinogenesis process (Al Zabadi et al., 2012; WHO,2009).

Darby (2005) performed a meta-analysis of residential radon and lung cancer from case-control studies consisting of 21,360 participants. Darby observed that persons exposed to elevated radon levels in their homes had a higher risk of developing lung cancer. USEPA (2012) estimated that radon gas was responsible for 21,000 deaths each year from lung cancer caused by radon gas exposure and that radon causes about 22% of lung cancer in the United States. Environmental exposures are a major determinant of health and illness. Thirty-seven years ago, in the first Healthy People report, Surgeon General Richmond specified that environmental factors contribute directly or indirectly to all the important chronic diseases (U.S. Department of Health, Education, and Welfare, 1979). Since that time, a variety of research programs have further identified associations between specific environmental exposures and specific adverse health outcomes. For instance, reviews and meta-analyses of research report that there are known adverse health effects related to exposure to lead (Lanphear et al., 2005; Lidsky & Schneider, 2003), mercury (Clarkson & Magos, 2006), air pollution (Dixon, 2002; Levy, Hammitt, & Spengler, 2000), radon (Darby, 2005; Liu et al., 2007; Marcinowski, Lucas & Yeager, 1994) and asbestos (Liu et al., 2007). The WHO (2009) estimated that globally 24% of overall disease burden and 23% of premature death are attributable to modifiable environmental factors. For North America, these estimates are 14% and 15%, respectively (Pruss-Ustun & Corvalan, 2006, 2007). Much of this impact is through the effect of pervasive urban air pollution on cardiovascular, respiratory diseases and cancer rates. In a critical study of 90 cities of the United States, Samet et al. (2000) found an association between day-to-day changes in

particulate matter air pollution and both mortality rates and hospitalizations of the elderly on subsequent days. Krewski et al. (2005) performed a correlational systems analysis of seven case-control studies of radon exposure and risk of lung cancer. They found that there is evidence of an association between residential radon gas exposure and lung cancer risk.

There have been various studies conducted regarding radon gas awareness and public perceptions of radon gas as a health hazard (Abramson, Barkanova & Redden, 2014; Baldwin, Fran & Fielding, 1998; Duckworth, 2002; Hazar et al., 2014; Kennedy, Probart & Dorman, 1991; Rinker, Hahn & Rayens, 2014; Shendell & Carr, 2013; Wang, Ju, Stark & Teresi, 2000; Weinstein, Sandman & Roberts, 1991; Weinstein et al, 2008). Mostly, these studies seek to identify correlates of risk perception, with demographics such as gender, age, income, educational level, race, property ownership and years at the property. Radon gas knowledge has been correlated with other demographics. Results from these studies show positive correlations between educational levels and accurate understanding of health risks from radon gas exposure (Duckworth, 2002). Baldwin, Fran & Fielding (1998) surveyed 4,501 female physicians and showed that knowledge of radon gas health risks did not necessarily result in higher radon testing rates. Out of the physicians surveyed, 82% had not conducted radon screening in their homes although the rate of testing was still 2 to 6 times higher than the general public. Abramson, Barkanova & Redden (2014) conducted a cross sectional study on 152 homeowners of Nova Scotia assessing radon knowledge. They found that a significant positive relationship exists between knowledge and concern about radon. However, their study reported that when knowledge is high, levels of concern remain relatively low. They concluded that government intervention to address the radon exposure problem is required to address residential radon

testing and mitigation. Wang, Ju, Stark & Teresi (2000) conducted a radon awareness and remediation survey among New York State residents to measure general awareness and factual knowledge about radon and prevalence of radon testing and remediation in the population. Their cross-sectional survey found that 82% of 1209 respondents had heard of radon, but only 21% were knowledgeably aware of radon. Only 15% of respondents who were aware of radon had their homes tested. The survey also reported that the percentage of residents surveyed who were aware of radon increased with increasing educational level. They concluded that the New York public awareness campaign that targeted high radon areas did not succeed in increasing public awareness and promoting residential radon testing. Shendell & Carr (2013) conducted a cross-sectional survey on the physical conditions of homes and their effects on measured radon levels based on the data collected from Hillsborough Township in New Jersey. They found that 50% of homes with perimeter drain and 30% of houses with sump pit were at 4.0 picocuries per liter or higher which exceeded the New Jersey and federal radon action level. They also found out that 47% of homes with sump and perimeter French drain also exceeded the action level threshold. They suggested that certain physical conditions act as pathways allowing radon entry into homes. Hazar et al. (2014) conducted a cross-sectional study on the exposure to indoor residential radon perceived risk and its relationship to willingness to test among health care providers. They surveyed 462 health care workers and found that 67% of respondents heard about radon before the study and 83.5% of those who heard about radon recognized radon gas as being hazardous. However, 34.5% of the respondents who heard about radon before the study identified radon gas exposure as a major precursor of lung cancer. Overall, 33% of the 310 respondents in the survey had conscious awareness about radon gas.

Those who had previously heard about radon gas (73%) were more willing to test their houses, had high perceived risk and were more willing to pay for radon test kits. Rinker, Hahn & Rayens (2014) conducted a cross-sectional, non- experimental study on residential radon testing intentions, perceived radon severity, and tobacco use. Of the 129 respondents surveyed, the strongest predictors of radon testing intentions were perceived severity, social influence, and current smoking. Participants with higher perceived severity were nearly eight times more likely to plan to test. Demographically, perceived severities were highest among females and those rating combined radon and tobacco smoke exposure as much riskier than tobacco smoke alone. Planning to test was seven times greater when somebody knows a person that has tested for radon in the past. Smoking status correlated to the intention of testing and revealed that current smokers were six times more likely to plan to test than non-smokers.

Studies have shown that subjects who had high perceived risks about radon gas exposure tend to exhibit higher levels of information seeking behavior and were the most knowledgeable regarding treating radon as a potential health issue (Kennedy, Probart & Dorman, 1991; Weinstein, Sandman & Roberts, 1991). Subjects with these traits were most likely to retest their homes for radon when elevated levels were detected (Halpern & Warner, 1994). Weinstein et al. (2008) conducted an experimental study on 1,897 homeowners in Columbus Ohio focusing on radon testing to examine several aspects of the PAPM. They found that there was an increase in radon test orders among groups especially those who were undecided compared to those who decided but did not follow up with buying a test kit or testing for radon gas in their homes. Desvouges, Smith & Rink (1992) surveyed 1000 Maryland residents in their experimental study to determine the best way of communicating radon risk

effectively to residents. They surveyed three counties; one county received community-based program alone; the second county received both the community-based program and media program, the third county did not get any special radon testing information. The second county, the one that received both the community-based and media program, had a 15%-point increase in attitudes favorable toward radon testing, 15%-point increase in knowledge and 8.2%-point increase in testing in comparison with the county that did not receive the media program and baseline community-based program. They concluded that policymakers do not know how to design a radon risk communication program. The researchers noted that policymakers used a one size fits all approach for radon community-based program and media program, instead of tailoring programs to community needs.

Abramson, Barkanova & Redden (2014) performed a descriptive, cross-sectional survey of 152 homeowners regarding their radon knowledge and found a positive relationship between knowledge and concern. Homeowners who are more concerned about radon already knowledge about the health hazards of radon. They reported that the government needs to address residential radon testing as the public is not very aware of the health risks caused by radon gas in the community going by the percentage of people testing their homes compared to the residents that have heard about the health risks of radon gas exposure. Poortinga, Bronstering & Lannon (2011) surveyed 1,578 residents utilizing a cross-sectional, mixed method study design. They explored United Kingdom residents' radon exposure risk awareness, concern, and behavior. They found that radon roll-out (awareness) program has been effective in raising awareness and testing rates in the public compared areas that did not receive the roll-out program. Hill, Butterfield & Larsson (2006) performed a cross-sectional survey of 131

households regarding radon risk exposure. They found that low-income rural citizens of Maryland do not understand the risk of radon exposure. This suggests that demographics should be considered in order to tailor the right message to the public regarding radon risk awareness and testing.

Halpern and Warner (1994), using data from the 1990 National Health Interview Survey, conducted a statistical analysis to explore radon knowledge, perception of radon as a health hazard and mitigation behavior compared to demographic factors. They found that about one-third of the 28,000 respondents answered correctly and identified lung cancer as associated with health effect of radon. They also found a significant relationship between having accurate radon information and being willing to employ radon mitigation techniques when the personal perceptions of radon are high because of radon present in a home.

In summary the above studies identified radon gas exposure as a serious health risk which should be made known to the general public. Public awareness brings better knowledge and increases perception of radon gas exposure which leads to testing for radon gas and mitigation in homes with elevated radon gas levels.

Risk Perception

Given the known relationships between environmental exposures and health outcomes, it is important that people act to protect themselves from exposures. These actions include changes in lifestyle or behavior to reduce exposures that may affect health. Some of these potential actions may be successfully undertaken by an individual, while others require groups of people working together to effect change in a community (Persky et al., 2007). The WHO

(2002) suggests that individuals' understanding of risk associated with specific environmental exposures is often different from evidence as assessed by research scientists (Cohrssen & Covello, 1989). Likewise, engagement in health-protecting behaviors often falls short of recommendations from environmental health and clinical experts (WHO, 2009).

It is important to understand the way people engage environmental health issues, what people think about matters of environmental health and what people do to reduce environmental risks to health (Dixon & Dixon, 2002; Dixon, 2002). People tend to have a variety of experiences and thoughts related to these concerns, and they tend to use a variety of methods for mitigating or reducing what they see as potentially harmful effects. Dixon et al. (2009) called these thoughts and behaviors environmental health engagement and commented that more knowledge about environmental health engagement would be an added tool for public health nurses and other healthcare practitioners to understand their clients' decision-making, as well as broader patterns of environmental health engagement in their communities.

Risk perception has long been conceived and empirically identified as a significant predictor of community's decision to adjust to a hazard (Terpstra, Lindell & Gutteling, 2009). Studies have suggested that higher levels of perceived risk increase protection motivation (Floyd, Prentice-Dunn & Rogers, 2000; Neuwirth, Dunwoody & Griffin, 2000). Conversely, the perception of a low-risk may silence people into a subtle sense of security, and as a result, lead them to overlook the risk as a threat that people should have been paying attention (Harris, 1996; Johnston, 1999; Spittal, McClure, Siegert & Walkey, 2005; Weinstein, 1980).

Risk perception may be an issue if members of the exposed population are unaware of the exposure or its potential health impacts or if they perceive danger in a way that does not

agree with assessments from scientists (WHO, 2002). For example, parents could underestimate the seriousness of children's exposure to radon (Hill, Butterfield & Larsson, 2006). However, although recognizing a threat may be a step toward taking action, it is not necessarily sufficient (Weinstein & Sandman, 1992a). Utilizing a stage model of precaution, research by Weinstein and Sandman (1992b) and Weinstein, Lyon, Sandman and Cuite (1998) propose that once there is a decision to act, situational factors become paramount. For example, in the context of home radon testing, the rate of testing is dramatically increased by the provision of information about a low-effort approach to testing, which is inexpensive and straightforward to implement (Weinstein, Lyon, Sandman and Cuite 1998). Prompt action on the part of an individual may be necessary to reduce the risk of adverse health outcomes. The WHO (2009) specified the use of public health workers such as medical doctors, nurses, environmental health specialist, health educators and pharmacist to reach target audiences as part of an essential component of a radon risk communication campaign.

In summary, when it comes to risk perception, communities should be aware of a health hazard to protect themselves from exposures. Risk perception could be formed from individual interaction or people working as group in a community. Risk perception is a significant predictor of a community or group decision to adjust to a hazard.

Public Health Workers Practice as Risk Communicators

Nurses

A report from the Institute of Medicine (IOM), on Nursing, Health, and the Environment, suggests that nurses are well situated to play a major role in the identification of adverse health outcomes associated with the environment. This role includes education of

clients on how they may protect themselves (IOM, 1995). Although the original focus of risk communication was the delivery of a message from an expert or knowledgeable professional to the public, it is now recognized that personal risk perception plays a major role in the adoption of health protective behaviors (Cohrssen & Covello, 1989; WHO, 2002). The risk communication role has expanded to incorporate a two-way interactive dialogue which is directly proportional. As the knowledge of those with whom one is communicating increases, the likelihood of achieving successful risk communication increases (Agency for Toxic Substances and Disease Registry, Centers for Disease Control and Prevention [ATSDR CDC], 2008; Cohrssen & Covello, 1989). The nursing professional's role in information dissemination requires nurses who can listen, interpret, clarify and reframe questions. It also requires nurses who can transmit information in emotionally charged and sometimes hostile situations (IOM, 1995).

With the knowledge of risk communication, public health nurses could better guide clients toward wiser choices for protecting their health, while also partnering with communities for reducing environmental hazards (WHO, 2002). There is a growing focus in this area exemplified by Butterfield's (2002) call for upstream thinking, which includes research on how individuals and communities may reduce their risks. An issue of Public Health Nursing highlighted increasing research emphasis, and also education, in this area of how nurses can partner with the community to reduce environmental hazards (Abrams & Hays, 2006). For supporting such efforts, it is critical that effective methods be available for assessing environmental health engagement (Dixon et al., 2009).

In the nursing profession, various studies have been conducted including the Environmental Risk Reduction through Nursing Intervention and Education study (ERRNIE). Hill,

Butter & Larsson (2006) conducted a cross-sectional study of 31 households with 131 participants on rural parents' perceptions of risk associated with their children's exposure to radon. They stated that ERRNIE is a 5-year project designed to check prevalence of numerous environmental exposures in rural children, evaluate public health nurses needs to integrate environmental health hazards into nursing practices, engage the public in educational materials geared toward environmental risk reduction strategies and deliver environmental risk mitigation to rural families. The ERRNIE project is vital because it takes advantage of the current public health infrastructure, which is already working with at-risk populations. These programs include Women, Infants, and Children, immunization clinics, and the Head Start program among others. Hill, Butter & Larsson (2006) concluded that low-income rural citizens do not understand their risk of radon gas exposure or the harmful consequences of exposure. Nurses can be used to engage these citizens increasing their knowledge and awareness towards risk perception to radon gas exposure.

Physicians as Risk Communicators

Trasande et al. (2006) conducted a descriptive study of 1500 New York State pediatricians to assess their self-perceived competency in dealing with common environmental exposures and diseases of environmental origin in children. They found that radon gas exposure ranked one of the lowest in health concern. Findings also indicate that New York pediatricians agree that children are suffering preventable illness of environmental origin, but they feel unprepared to educate families about common exposures. Pediatricians surveyed reported that apart from lead exposure, little prior training is offered about taking environmental histories and as a result physicians reported low self efficacy in discussing environmental

exposure with parents. Pediatricians had a difficult time locating diagnosis and treatment resources related to environmental exposure. The study concluded that among physicians, significant demand exists for evaluating environmental health concerns and for educational opportunities to address environmental causes of illness.

In another study Trasande et al. (2010) conducted a qualitative systematic review of healthcare provider capacity with the environmental health hazard self-administered survey. Their systematic review identified eight relevant studies which relied on self-reported questionnaires and surveys. Results showed that national and state samples consistently identified significant gaps in self-efficacy and knowledge about environmental health hazards across a broad range of physicians. The study concluded that gaps persist in physician's knowledge about environmental health nationwide and across all disciplines.

Pharmacists as Risk Communicators

Pharmacists' are one of the healthcare workers that have direct contact with the public. They can influence the public's healthcare decisions and act as risk communicators to the public regarding environmental issues concerning the public (Simmons-Yon et al., 2012). In their focus group study, Simmons-Yon et al. (2012) examined the experience of community pharmacists providing advice about symptoms, complementary and alternative medicines utilizing 21 pharmacists working in community settings that participated in four focus groups. Pharmacists' dual role as medical liaisons and advisors emerged as primary themes. The pharmacits' participants reported that patients often seek their advice about self-care of symptoms to delay physician visits. Participants were comfortable giving advice. However, the unavailability of patients' medical histories decreased their comfort level. Most pharmacists' were uncomfortable recommending complementary and alternative medicine (CAM). They

reported that this was because of the lack of regulation and evidence. Participants suggested that pharmacy curricula expand training on symptom triage, pharmacist-patient risk communication, and CAM to prepare graduates for employment in community settings. Student and licensed pharmacists' that participated in the study expressed a lack of knowledge on symptom management but reported needing training and better risk communication skills to help provide appropriate advice to patients. The study findings suggest that training strategies could help pharmacists appropriately triage and counsel patients seeking self-advice for their symptoms in the community setting.

Odedina et al., (2008) measured pharmacists' knowledge, attitudes and beliefs in a cross-sectional survey of 89 pharmacists to explore their role as health educators and risk communicators in the prevention of prostate cancer mortality in Florida. They found that although study participants were willing to be health educators and risk communicators, their knowledge base about prostate cancer prevention and early detection served as a barrier to action.

Registered Environmental Health Specialists (REHS) as Risk Communicators

REHS's or Registered Sanitarians (RS) normally referred to as health inspectors or sanitarians are people certified to improve the health status of the community they serve and maintain their quality of life through consultation, enforcement, and environmental education (NACCHO, 2011a). Many of those who are REHS certified, work for the government. NACCHO (2011a) reported that the typical program responsibilities include food protection, land use, recreational swimming, onsite sewage disposal, drinking water, housing, vector control, disaster sanitation, solid waste and hazardous materials management. Typical duties of REHS in

a public health department include but not limited to inspections of food establishments, community drinking water systems, public swimming pools, landfills, underground storage tanks, lead, radon, asbestos and general sanitary inspections to determine compliance with federal, state and local statutes, regulations and ordinance. REHS investigates nuisances and violations regarding sanitary and environmental hazards. They conduct activities related to licensing and operation of facilities, collects water, food and other specimens for laboratory analysis and interpret results of same. They investigate foodborne, airborne, waterborne and other suspected disease outbreaks and keeps reports or records of findings and serve as a witness in court proceedings regarding public health issues. REHS assemblies, reviews and utilizes articles, bulletins, demonstrations and other educational methods and materials concerning various phases of environmental sanitation (NACCHO, 2011a).

REHS's daily come in contact with the public and are the frontline in enforcement within many health departments across the United States. They are the second largest professionals among public health workforce as they daily carry out their duties of testing homes for radon and other environmental hazards (NACCHO, 2011a, 2011b). Environmental health scientists control, prevent and eliminate environmental health risks and evaluate environmental health threats through scientific investigations (USDHHS, 2000). Being that they work in the field and interact with the public while enforcing applicable laws, rules, and regulations, REHS's can be a vital tool in communicating health risks especially radon being an environmental hazard to the public (WHO, 2006).

Health Educators as Risk Communicators

Health educators are people who teach the public about behaviors that promote wellness through developing and employing strategies to improve the health of individuals and communities. According to the study conducted by NACCHO (2011a, 2011b), health educators develop health education program to address community health needs, identify target populations and assess health education needs based on information from community health plans and other relevant data. They involve local community leaders in the planning, implementation, and maintenance of health education services and programs. Health educators evaluate the effectiveness of programs geared towards health change in communities while helping the public find health services (WHO, 2006). NACCHO (2011a) reported that health educators like other public health workers at local health departments play a critical role in promoting and protecting the health of communities across the United States. They search for ways to avoid or delay the onset of disease, illness, and injury and as part of the public health workforce ensures safe environments and promote the health, equity and well-being of communities they serve (NACCHO, 2011a, 2011b).

In their study, Balicer, Omar, Barnett & Everly (2006) surveyed local public health worker's perceptions toward responding to an influenza pandemic and found that health educators working in public health departments could be utilized as clinical staff to educate the public better about pandemic influenza as well as other pressing health issues. In the same vein, Taylor, Miro, Bookbinder & Slater (2008) studied innovative infrastructure in New Jersey, using health education professionals to inform and educate the public during health crises.

They identified how health educators are trained as risk communicators and used during health crises which can include diseases outbreaks, natural disaster or bioterrorism. Health educators provide a variety of programs in communities geared towards prevention, early detection, and or treatment. Health educator's primary responsibility makes them suitable to be risk communicators to the public regarding various environmental issues including radon. Health educators are better suited to explain radon gas hazards and follow up with the community regarding testing for radon and mitigation if necessary.

Public Health Workers Radon Training

According to NACCHO (2011a, 2011b), the local public health workforce is made up of individuals from various academic backgrounds, professional experiences, and credentials whose main goal is to improve and protect the health of communities. Curriculum for some public health workers while in training covers radon as a radioactive material from an occupational health and safety perspective rather than an environmental pollutant found in homes. Many surveys performed on some public health workers; physicians (Trasande et al., 2006; Trasande et al., 2010); nurses (Abrams & Hays, 2006; Dixon et al., 2009; IOM, 1995) and pharmacists (Odedina et al., 2008; Simmons-Yon et al., 2012) found that public health workers will be better prepared to serve as risk communicators to the general public if they have knowledge of environmental pollutants as health hazards. These studies consistently identified significant gaps in knowledge about environmental hazards among public health workers highlighting that while in training, healthcare workers did not have an appropriate knowledge of environmental health effects from radon and other environmental pollutants. Apart from

environmental health specialists or scientists whose jobs include regulating and enforcement of environmental pollutants, most other public health workers do not have a working knowledge of environmental pollutants. There are no known available studies to explain the extent to which public health workers who had specific degrees and certification in environmental health or public health have regarding risk to radon gas exposure.

The USEPA, National Center for Healthy Housing and the US Department of Health and Human Services had in-service training and online classes and webinars regarding radon gas in homes, designed for training healthcare workers and the general public regarding risk associated with radon gas exposure (USEPA, 2012). Several states have made efforts to encourage and provide outreach programs to physicians and other health care workers whose direct connections to their patients make them most influential in improving public health and individual lives (USEPA, 2012). Most health departments across the U.S. emphasize the importance of radon awareness and mitigation as it relates to public health. Some of the radon programs participate in hospital discharge for adults and newborns where patients are sent home with information including a radon kit for home testing (USEPA, 2012).

Risk Communication

Fitzpatrick-Lewis et al. (2010) conducted a systematic review of 24 published articles and concluded that the influence or usefulness of risk communication strategies is affected by personal risk perception, belief in the source of material and prior personal knowledge with emergencies. As well, the methods of delivering the messages are necessary. The findings suggest that a multimedia approach is better than a single media approach in reaching a broad

range of people. People partake in messages more efficiently when the message delivery incorporates personal interaction. They concluded that risk communication policies that integrate the needs of the target audience with a multi-faceted delivery method are effective at reaching the largest audience.

There may be barriers to an individuals' understanding a potential health risk. Insufficient proficiency may be a significant barrier to individuals' understanding of environmental, health, or other hazards (Peters, 2008). Therefore, the use of graphical displays has been recommended, especially for risk communication with low-numerate individuals (Lipkus, 2007). Risk ladders are graphical displays that have been widely used to communicate environmental risks. Most risk ladders provide comparisons with another risk to increase risk understanding (Visschers, Meerteens, Passchier & DeVries, 2007). Because studies have shown risk ladders to promote good decision making, they have been recommended for successful risk communication (Lipkus, 1999, 2007). Also, a risk ladder format that is intended to be understood by individuals with low numeracy skills should primarily provide a comparison with a common risk (Keller, Siegrist & Visschers, 2009).

Terpstra, Lindell and Gutteling (2009) reported that many studies focusing on individuals' adjustments to natural hazards recommend that public authorities use risk communication to enhance people's understanding of the dangers they face. In turn, elevated risk perceptions resulted in increased information-seeking behaviors, especially when people had received multiple risk information communications and identified others who had engaged in protective behavior (Terpstra, Lindell & Gutteling, 2009). Communicating environmental risks to the public dwells heavily on local public health workers as they are government employees

and are in the frontline of disseminating health information to the public and communities they serve (NACCHO, 2011a, 2011b).

The next chapter will explain the research methods used in this study including the design, participants, variables, inclusion and exclusion criteria's, sample size, survey instrument, procedure, reliability, validity and data analysis.

Chapter III

RESEARCH METHODS

Design

This study design is descriptive, correlational and cross-sectional. It is descriptive because it explored variables among public health workers. It identified patterns or trends, but not the causal linkages. It is correlational because it investigated associations between variables. It is cross sectional because it is performed at a single point in time and not over a period of time. This study is a survey research because it observed subjects using questionnaires and measures variables of interest. The principal investigator in this study explored knowledge, beliefs, personal and professional practices of radon gas exposure among public health workers. This study design and plan was submitted to Seton Hall University, and Institutional Review Board approval was obtained.

Study Participants

Public health workers who are employed by public health departments in New Jersey participated in this study. The public health workers that participated in this study are Health Educators, Health Officers, Nurses and Registered Environmental Health Specialists. The New Jersey Literacy Information and Communication System Health Services Portal (NJLINCS) Coordinator agreed to send out survey information to public health workers via the LINCS system. This portal is used by the New Jersey State Health Department to disseminate information to public health workers. The Health Alert Network has emails of public health

workers in the State of New Jersey. There are approximately 2300 public health workers employed by Public Health Departments in New Jersey.

Variables

The public health workforce is a collection of individuals from various academic backgrounds, professional experiences, and credentials. Public health workers are diverse in the type and amount of education and training they bring to their work. Public health workers may belong to a recognized health profession, come from other technical backgrounds, or be trained on the job in their agency based on their prior work experience or work specialization or career certification requirement.

The independent variables of this study are public health workers working at local public health departments in New Jersey. They include

- Registered Nurses
- Registered Environmental Health Specialist (REHS)
- Health Educators
- Health Officers

Covariates for this study are the demographics of participants

- Years of experience
- Age
- Gender
- Level of education
- Smoking status

- Residence status
- Length of residence
- Place of residence

The dependent variables for this study are

- Knowledge question scores
- Belief question scores
- Personal practice question scores
- Professional practice question scores

Inclusion/Exclusion Criteria

Inclusion Criteria for this study are

- Participant must be a public health worker working in a public health department in New Jersey
- Participants must be male or female, aged 18+
- Participants must have English proficiency in reading and writing

Exclusion Criteria for this study are

- Individuals who are not public health workers
- Individuals currently employed by Camden County Health Department (as the PI was employed by Camden Health Department)
- Individuals under 18 years

- Individuals who are not English proficient in reading and writing

Sample Size

An a priori power analysis for the goodness of fit test was used to determine the sample size appropriate to achieve adequate power to control for the possibility of failing to reject a false null hypothesis or committing a Type II error. This was preventable by achieving a minimum power of at least 0.8 (Portney and Watkins, 2008).

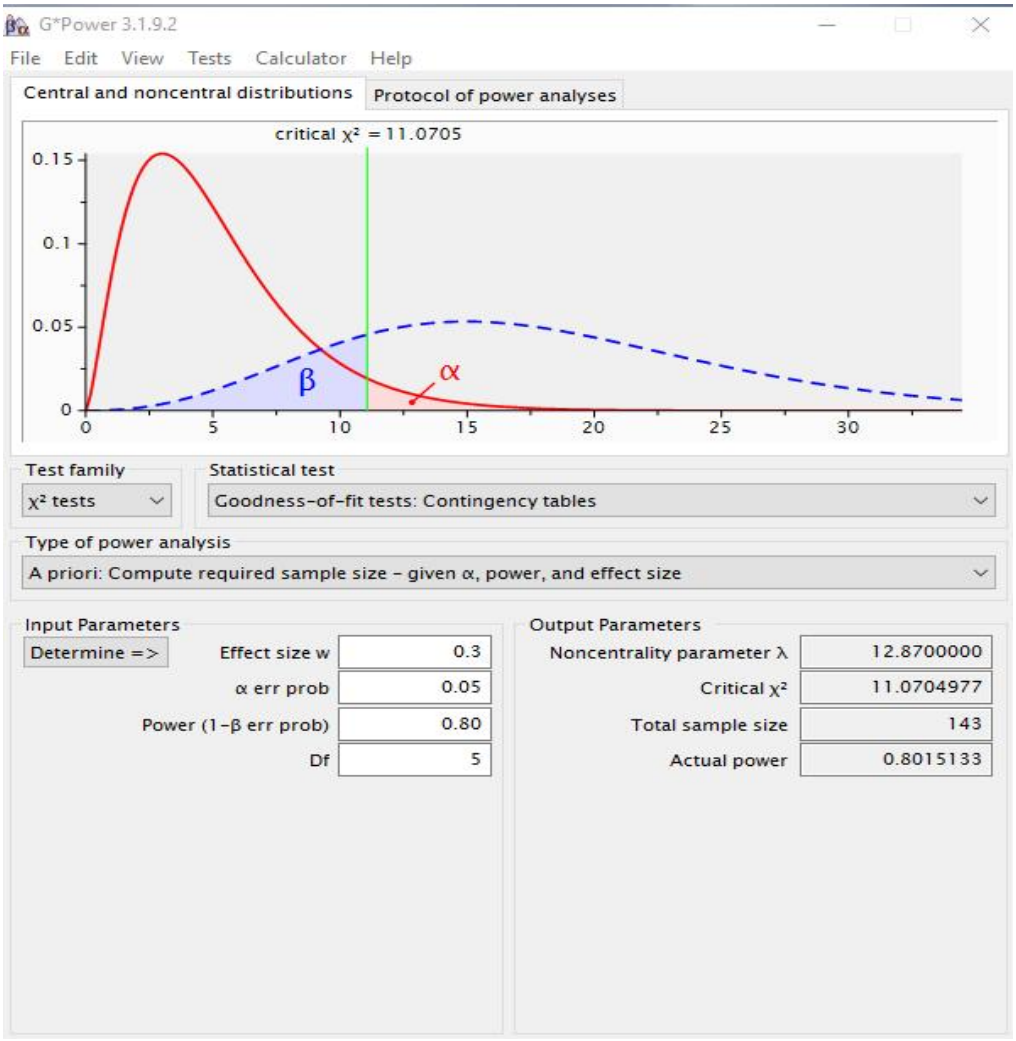

Figure 2. G Power Analysis. This figure illustrates the G Power a priori analysis for Chi-Square Goodness of fit test.

Using G*Power 3.1.9., a *p* level of 0.05 with a power of .80 and an effect size of 0.30 was used to calculate sample size. Figure 2 above shows that the minimum sample size required in this study was 145 participants. This number was also based on the number of variables studied. The actual sample size for this study was 386 participants. Figure 3 below shows a Post hoc G Power analysis for Chi-square goodness of fit with an effect size of 0.30, a *p* level of 0.01, 5 degrees of freedom and a sample size of 386. This resulted in a power is 0.99.

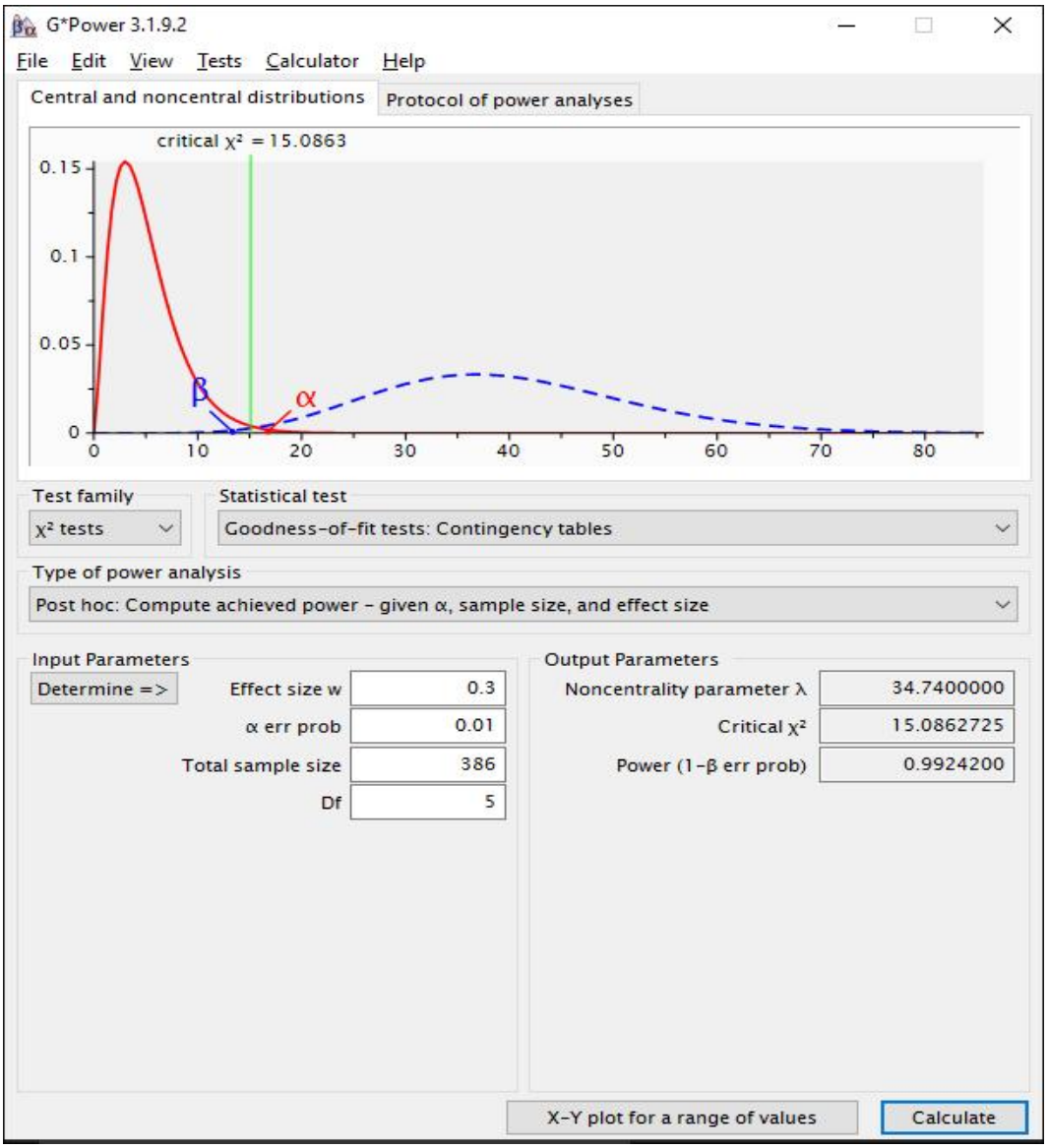

Figure 3. G Power Analysis. This figure illustrates the G Power post hoc analysis for Chi-Square Goodness of fit test.

Survey Instrument

A survey instrument was developed specially for this study from thematic topics in the literature and engagement with authors that had expertise in radon and environmental hazards research (Rinker, Hahn & Rayens, 2014; Rosenthal, 2011; Weinstein et al., 1991; Weinstein,

Lyon, Sandman & Cuite, 1998; Weinstein, Sandman & Blalock, 2008). Face and content validity were established using a modified Delphi panel (Hansson, Keeney & Mckenna, 2000; Powell, 2003). Delphi is a technique that utilizes an expert review to establish a consensus on the study instrument and determines how well the study instrument questions measures the study constructs. Delphi validation relies on convergent validity to confirm the face validity of the tool among blinded experts. This is achieved by comparing the panel of experts' ratings after the fact without allowing them to discuss the content before the response (Linstone, 1975). The Delphi panel for this study consisted of six experts who were primary authors of a major journal publication on radon and environmental hazards. Experts assessed questions for agreement with constructs in the scoring schematic and provided feedback to explain their choices. The survey instrument was modified and the process repeated twice because that was when greater than 80% of the panel agreed constructs represented and language used were consistent with the standard of practice in radon research. The survey instrument (questionnaire) consists of 5 point Likert scale, true or false, yes or no and multiple choice selection. The survey instrument consists of 50 questions. There are 12 knowledge questions, 12 belief questions, 5 personal practice questions, 9 professional practice questions and 13 demographic questions.

Reliability and Validity

The 50 question Public Health Workers Radon Assessment Instrument (PHWRAI) was developed and used for this study. This measured knowledge about radon, perceptions of radon, personal practices of testing for radon as related to home radon testing and professional practices about educating the public about testing for radon as part of the job of public health

workers. Dependent variables are knowledge, beliefs, and practices. Independent variables are the various public health workers and demographics such as age, years practiced in the field of public health, gender, education, smoking status, residence status and length at residence. Components of the survey instrument include questions that address knowledge, beliefs, personal practices and professional practices about radon gas risk exposure.

The internal consistency of the PHWRA survey instrument was assessed utilizing Cronbach's alpha coefficient. Cronbach's Alpha is a summary measure of internal consistency reliability that is based on calculating the amount of inter-correlation or relationship between all items at the same time (Cronbach, 1951). It is a commonly used estimate for the reliability of psychometric tests. A psychometric instrument with an alpha score of greater than 0.6 is conventionally considered to have acceptable internal consistency. Each of the four scales was analyzed for internal consistency. An overall alpha was also calculated for the entire survey tool. Cronbach's Alpha for the PHWRA survey instrument with all four scales is .755 which is considered acceptable by George and Mallery (2003). The Professional Practice Scale scored a Cronbach's alpha of .945. The Personal Practice Scale scored a Cronbach's alpha of .703. The Beliefs Scale scored a Cronbach's alpha of .806. The Knowledge Scale scored a Cronbach's alpha of .710. The PHWRA Knowledge Scale items are individual radon knowledge questions from prior studies in the literature to measure cognitive radon knowledge.

Procedure

After obtaining approval from Seton Hall IRB, the principal investigator sent a solicitation letter to the New Jersey Health Alert Network Coordinator to send out to all public

health workers via the New Jersey Literacy Information and Communication System Health Services Portal (NJLINCS) (See appendix A). Public health works that decided to take part in the study received a link to Survey Monkey through the solicitation letter, where public health workers completed the survey instrument. The principal investigator sent out reminder emails at two weeks and one month after the initial circulation to the New Jersey Health Alert Network Coordinator to further circulate the solicitation letter to all public health workers (See Appendix C). Figure 4 shows the survey process from draft survey questions through data collection and analysis.

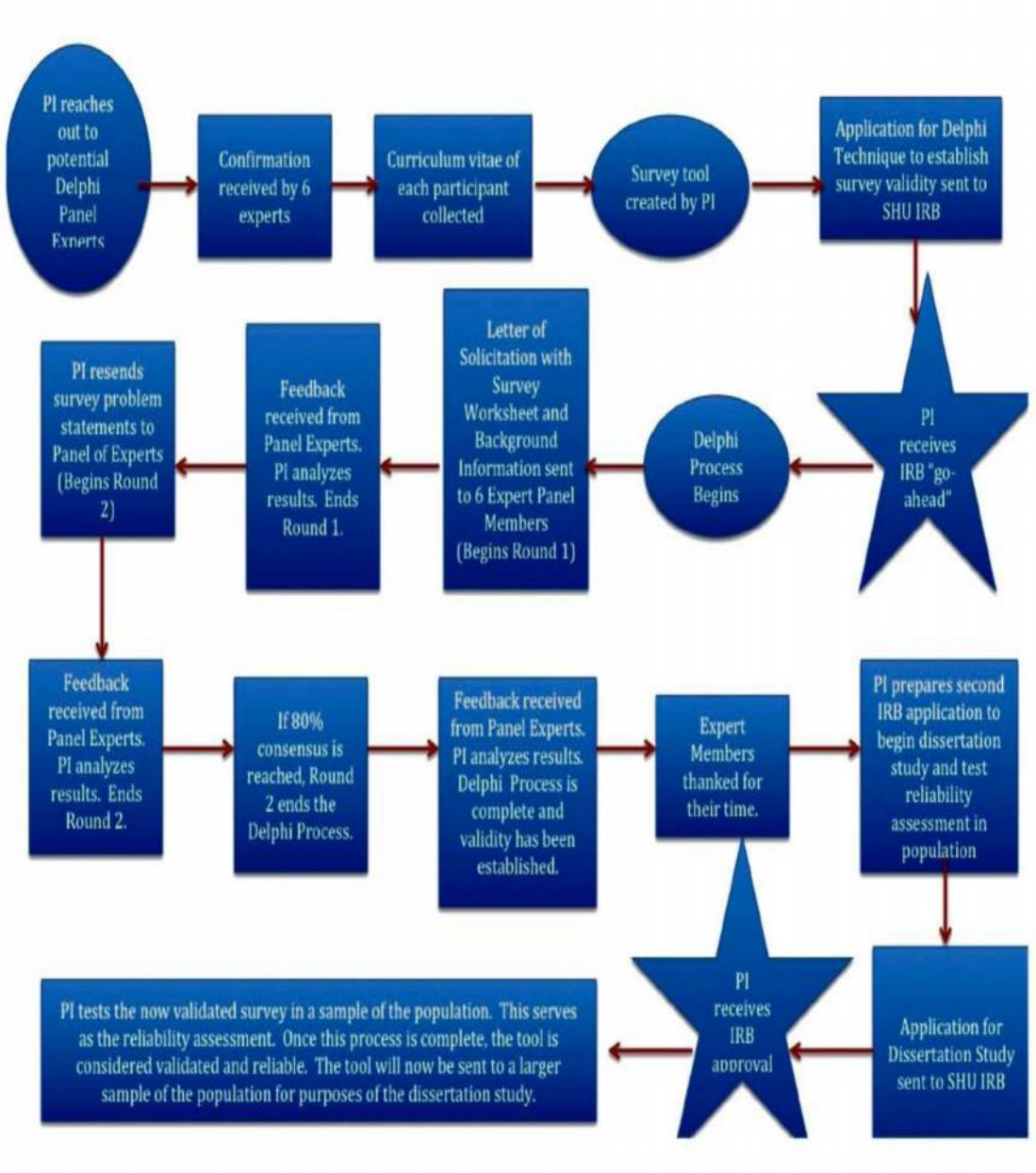

Figure 4. Survey Process. This figure illustrates the various aspects of the survey process

Data Analysis

SPSS version 24.0 was used for the analysis of data. Descriptive statistics were used to analyze the demographics of the participants. The univariate and bivariate analysis were performed between independent variables among various public health workers. Chi-square

test of association was used to test relationships between public health worker's professional practices and their knowledge, beliefs and personal practices. Chi-square test of differences was used to test differences between public health worker's knowledge, beliefs, personal and professional practices. The Principal Investigator utilized the graphical representation of histograms and bar charts to explain sample demographics.

Twelve general knowledge questions about radon was treated as nominal data. Twelve beliefs questions about perceptions of radon was treated as ordinal data. Five personal practices questions about home radon testing was graded as nominal data. Four professional practices questions about educating the public as part of public health workers job were treated as nominal data. Data from demographic questions about age, years practiced in the field of public health, and length at the residence were treated as ratio data. Data from demographic questions about public health job title, gender, smoking status, renting status were treated as nominal data.

For hypothesis 1a, Chi-square test of differences was used to test differences in professional practices among public health workers. There are independent categorical (nominal; types of public health workers) and dependent categorical (nominal; professional practices questions score) variables. Answers to professional practices questions are nominal. For Hypothesis 1b, Chi-square test of independence was used to test the relationship between knowledge (nominal) and professional practices (nominal) about radon gas exposure among public health workers.

For hypothesis 2a, Chi-square test of differences was used to test the differences in knowledge among public health workers. Answers to knowledge questions are nominal. There

are independent categorical (nominal; types of public health workers) and dependent categorical (nominal; knowledge questions score) variables. For hypothesis 2b, Chi-square test of independence was used to test relationships between knowledge (nominal) and personal practices (nominal) about radon gas exposure among public health workers.

For hypothesis 3a, Kruskal-Wallis test was used to test the differences in beliefs among public health workers. There are independent categorical (nominal; types of public health workers) and dependent categorical (ordinal; beliefs questions score) variables. For hypothesis 3b, Chi-square test of independence was used to test the relationships between beliefs (ordinal) and professional practices (nominal) about radon among public health workers.

For hypothesis 4a, Chi-square test of differences was used to test the differences in personal practices regarding radon gas exposure among public health workers. There are independent categorical (nominal; types of public health workers) and dependent categorical (nominal; personal practices) variables. For hypothesis 4b, Chi-square test of independence was used to test the relationship between personal practices (nominal) and professional practices (nominal) about radon gas exposure among public health workers.

Chapter IV

RESULTS

Sample Characteristics

There was a total of 386 completed surveys in this study. The majority of participants (50.52%) were between 31-40 years of age. The largest number of participants (48.44%) had between 10-19 years of experience in the field. Primarily four types of public health workers completed the survey. They are Health Educators, Health Officers, Nurses and Registered Environmental Health Specialists.

Gender

72.30% of the sample were females, and 27.70% were males. Health Educators that participated in the study were 5.20% males and 22.50% females. Health Officers comprised of 4.70% males and 8.30% females. Nurses had 3.40% males and 22.50% females. Registered Environmental Health Specialists (REHS) were the largest group that participated in the study with 14.50% males and 18.90% females.

Job Title

There are 107 (27.70%) Health Educators, 50 (13.00%) Health Officers, 100 (25.90%) Nurses and 129 (33.40%) Registered Environmental Health Specialists (REHS).

Table 1

Participant Job Title (n=386)

Job Title	Frequency	Percent
Health Educator	107	27.7
Health Officer	50	13.0
Nurses	100	25.9
REHS	129	33.4

Age

The age group, 20-30 years of age, had 38 respondents. There were 195 respondents within 31-40 years. The second largest age group (41-50 year olds) had 88 participants. 51-60-year-olds had 48 participants. 61-70-year-olds had 16 participants. One participant was greater than 70 years of age.

Table 2

Participant Age Group (n=386)

Age Group	Frequency	Percent
20-30 years of age	38	9.8
31-40 years of age	195	50.5
41-50 years of age	88	22.8
51-60 years of age	48	12.4
61-70 years of age	16	4.1
<70 years of age	1	0.2

Education

The largest represented group of public health workers had a Bachelor's degree (69.4%). Out of this 17.4% practice as Health Educators, 1.80% were Health Officers, 22.0% were Nurses, and 28.2% were Registered Environmental Health Specialists. Master's Degree was the second highest degree earned by the study participants (27.5%). Out of this 10.1 % practiced as Health Educators, 9.80% were Health Officers, 2.80% practiced in the Nursing Profession and 4.70% were Registered Environmental Health Specialists. Five participants had a doctorate (1.3%) working in the field of public health as follows: Health Educators 0%, Health Officers 0.8%, Nurses 0.3% and Registered Environmental Health Specialists 0.3%. A total of 2 participants (0.5%) had High School Diploma and 5 participants (1.3%) had an Associate Degree.

Table 3

Participant Education (n=386)

Education	Frequency	Percent
High School Diploma	2	0.5
Associate Degree	5	1.3
Bachelor's Degree	268	69.4
Master's Degree	106	27.5
Doctorate Degree	5	1.3

Years Practiced in the Field

Within the group 10-19 years of practicing in the field of public health, Registered Environmental Health Specialist had the highest number of participants (31.0%). Nurses had 27.82%, Health Officers had 13.36%, and Health Educators had 27.82%. There were 30.31% of

study participants who have practiced for less than 1 year and up to 9 years in the field. 13.73% of respondents have practiced between 20-29 years in the field. 6.73% of study participants practiced for 30-39 years in the field of public health. 0.78% of study participants have practiced for more than 40 years in the field of public health.

Table 4

Participant Years Practiced in the Field (n=386)

Age Group	Frequency	Percent
<1-9 years	117	30.3
10-19 years	187	48.4
20-29 years	53	13.7
30-39 years	26	6.7
>40 years	3	0.8

Smoking Status

Public health worker's response to the demographic question "Are you a current smoker" showed that an overwhelming 97.7% (n=377) of public health workers answered "No" and 2.3% (n=9) answered "Yes" that they were current smokers when the survey was administered. Of the respondents that answered no to the question, 27.5% (n=106) were Health Educators, 12.5% (n=47) were Health Officers, 25.9% (n=100) were Nurses and 32.1% (n=124) were Registered Environmental Health Specialists. Of the respondents that answered yes to the question, 1 respondent identified as a Health Educator, 3 respondents were Health Officers, none identified as a Nurse and 5 respondents were Registered Environmental Health Specialists.

Public health worker's response to the demographic question "Are you a former smoker" showed that 42.0% (n=162) of public health workers answered "Yes" and 58.0% (n=224) answered "No" that they are not former smokers. Of the respondents that answered yes to the question, 10.9% (n=42) were Health Educators, 2.6% (n=10) were Health Officers, 13.5% (n=52) were Nurses and 15.0% (n=58) were Registered Environmental Health Specialists. Of the respondents that answered no to the question, 16.8% (n=65) were Health Educators, 10.4% (n=40) were Health Officers, 12.4% (n=48) were Nurses and 18.4% (n=71) were Registered Environmental Health Specialists.

Public health worker's response to the demographic question "Have you smoked at least 200 cigarettes in your life", showed that 9.6% (n=37) answered "Yes" and 90.4% (n=349) answered "No". Out of the respondents that answered to the question, 3.7% (n=4) were Health Educators, 2.3% (n=9) were Health Officers, 1.0% (n=4) were Nurses and 5.2% (n=20) were Registered Environmental Health Specialists. Of the respondents that answered yes to the question, 26.7% (n=103) were Health Educators, 10.6% (n=41) were Health Officers, 24.9% (n=96) were Nurses and 28.2% (n=109) were Registered Environmental Health Specialists.

On the demographic question "Do you now smoke", 1.6% (n=6) stated that they presently smoke every day, 1.0% (n=4) responded that they smoke some days and 97.4% (n=376) stated that they do not smoke at all. Of the respondents that stated that they do not smoke at all, 27.5% (n=106) were Health Educators, 12.7% (n=49) were Health Officers, 25.4% (n=98) were Nurses and 31.9% (n=123) were Registered Environmental Health Specialists.

Table 5

Participant Smoking Status "Do you now smoke" (n=386)

Response	Frequency	Percent
Everyday	6	1.6
Somedays	4	1.0
Not at all	376	97.4

Residence Status

On the demographic question "Do you own the residence where you live", 66.3% (n=256) answered yes and 33.7% (n=130) answered no. Of the respondents that answered yes, 16.8% (n=65) were Health Educators, 10.6% (n=41) were Health Officers, 17.1% (n=66) were Nurses and 21.8% (n=84) were Registered Environmental Health Specialist. Of the respondents that answered no, 10.9% (n=42) were Health Educators, 2.3% (n=9) were Health Officers, 8.8% (n=34) were Nurses and 11.7% (n=45) were Registered Environmental Health Specialists.

The majority of respondents rent rather than own their place of abode. On the demographic question "Do you own where you live, 31.6% (n=122) answered yes while 68.4% (n=264) answered no. Of the respondents that answered yes, 10.1% (n=39) were Health Educators, 1.6% (n=6) were Health Officers, 8.8% (n=34) were Nurses and 11.1% (n=43) were Registered Environmental Health Specialists. Of the respondents that answered no, 17.6% (n=68) were Health Educators, 11.4% (n=44) were Health Officers, 17.1% (n=66) were Nurses and 22.3% (n=86) were Registered Environmental Health Specialists.

The majority of the respondents have lived in their current residence between 10 and 19 years. On the demographic question “How many years have you lived in your current residence”, 40.9% (n=158) of the respondents stated that they have lived in their residence between less than 1 year and 9 years. 43% (n=166) of the respondents have lived in their residence between 10 and 19 years. 13% (n=50) of the respondents have lived in their residence between 20 and 29 years. 3.10% (n=12) of the respondents have lived in their residence for more than 30 years. Of the respondents who have lived in their residence between less than 1 year and 9 years, 14.5% (n=56) were Health Educators, 3% (n=11) were Health Officers, 8.6% (n=36) were Nurses and 15.3% (n=55) were Registered Environmental Health Specialists. Of the respondents who lived in their residence between 10 and 19 years, 9.5% (n=37) were Health Educators, 6.5% (n=25) were Health Officers, 12.9% (n=50) were Nurses and 14.1% (n=54) were Registered Environmental Health Specialists. Of the respondents who lived in their residence between 20 and 29 years, 3.5% (n=13) were Health Educators, 2.6% (n=9) were Health Officers, 3.2% (n=12) were Nurses and 3.7% (n=16) were Registered Environmental Health Specialists. Of the respondents who lived in their residence for over 30 years, 0.3% (n=1) were Health Educators, 1.5% (n=5) were Health Officers, 0.6% (n=2) were Nurses and 0.7% (n=4) were Registered Environmental Health Specialists.

Table 6

Participant Years Lived in Residence (n=386)

Age Group	Frequency	Percent
<1-9 years	158	40.9
10-19 years	166	43.0
20-29 years	50	13.0
51-60 years of age	12	3.1

Personal Practices about Radon

On the personal practices question "I know how to test for radon", the majority of public health workers stated that they do not know how to test for radon. 35% (n=135) answered yes to the question, and 65% (n=251) answered no to the question. Of the respondents that know how to test for radon, 9.8% (n=38) were Health Educators, 10.6% (n=41) were Health Officers, 1.0% (n=4) were Nurses and 30.7% (n=52) were Registered Environmental Health Specialists. Of the respondents that do not know how to test for radon, 17.9% (n=69) were Health Educators, 2.3% (n=9) were Health Officers, 24.9% (n=96) were Nurses and 19.9% (n=77) were Registered Environmental Health Specialists.

On the question, "I have purchased a radon test kit", the majority of public health workers stated that they had not purchased a radon test kit. 12.2% (n=47) answered yes to the question, and 87.8% (n=339) answered no to the question. Of the respondents that have purchased a radon test kit, 1.0% (n=4) were Health Educators, 6.0% (n=23) were Health Officers, 0.3% (n=1) were Nurses and 4.9% (n=19) were Registered Environmental Health Specialists. Of the respondents that have not purchase a radon test kit, 26.7% (n=103) were

Health Educators, 7.0% (n=27) were Health Officers, 25.6% (n=99) were Nurses and 28.5% (n=110) were Registered Environmental Health Specialist.

On the question, “I plan to perform a radon test in my home”, the majority of public health workers stated that they plan to perform a radon test in their homes. 70.2% (n=271) answered yes to the question, and 29.8% (n=115) answered no to the question. Of the respondents that plan to perform a radon test in their homes, 21.2% (n=82) were Health Educators, 3.9% (n=15) were Health Officers, 23.3% (n=90) were Nurses and 21.8% (n=84) were Registered Environmental Health Specialists. Of the respondents that do not plan to perform a radon test in their homes, 6.5% (n=25) were Health Educators, 9.1% (n=35) were Health Officers, 2.6% (n=10) were Nurses and 11.7% (n=45) were Registered Environmental Health Specialists.

On the question, “I have completed a radon test in my home”, the majority of public health workers stated that they had not completed a radon test in their homes. 16.3% (n=63) respondents stated that they had completed a radon test in their homes and 83.7% of the respondents stated that they had not completed a radon test in their homes. Of the respondents that completed a radon test in their homes, 4.9% (n=19) were Health Educators, 4.9% (n=19) were Health Officers, 0.3% (n=1) were Nurses and 6.2% (n=24) were Registered Environmental Health Specialists. Of the respondents that have not completed a radon test in their homes, 22.8% (n=88) were Health Educators, 8.0% (n=31) were Health Officers, 25.6% (n=99) were Nurses and 27.2% (n=105) were Registered Environmental Health Specialists. Table 7 below summarizes the results concerning public health workers’ personal practices about radon gas exposure.

Table 7

Participant Personal Practices about Radon (n=386)

Response	Frequency	Percent
I know how to test for radon		
YES	135	35.0
NO	251	65.0
I have purchased radon test kit		
YES	47	12.2
NO	339	87.8
I plan to perform a radon test in my home		
YES	271	70.2
NO	115	29.8
I have completed a radon test in my home		
YES	63	16.3
NO	323	83.7

Professional Practices about Radon

The majority of the public health workers in this study stated that they have not informed members of the public about the hazards of radon. On the question "I have informed members of the public about the hazards of radon", 18.1% (n=70) of the respondents stated that they have informed members of the public about the hazards of radon, while 81.9% (n=316) of the respondents stated that they have not informed members of the public about the hazards of radon. Of the respondents that have informed the public about the hazards of radon, 4.9% (n=19) were Health Educators, 5.4% (n=21) were Health Officers, 0.8% (n=3) were Nurses and 7.0% (n=27) were Registered Environmental Health Specialists. Of the respondents

that have not informed the public about the hazards of radon, 22.8% (n=88) were Health Educators, 7.5% (n=29) were Health Officers, 25.1% (n=97) were Nurses, and 26.4% (n=102) were Registered Environmental Health Specialists.

On the question, “I have urged members of the public to test their homes for radon”, majority of the public health workers stated that they have not urged members of the public to test their homes for radon”. 14.8% (n=57) of the respondents urged members of the public to test their homes for radon while 85.2% (n=329) of the respondents have not urged members of the public to test their homes for radon. Of the respondents who urged members of the public to test their homes for radon, 4.4% (n=17) were Health Educators, 4.7% (n=18) were Health Officers, 0.5% (n=2) were Nurses and 5.2% (n=20) were Registered Environmental Health Specialists. Of the respondents who have not urged members of the public to test their homes for radon, 23.3% (n=90) were Health Educators, 8.3% (n=32) were Health Officers, 25.4% (n=98) were Nurses and 28.2% (n=109) were Registered Environmental Health Specialists.

The majority of public health workers in this study stated that they have not informed the public about the combined effect of smoking and radon exposure. On the question “I have informed the public about the combined effect of smoking and radon exposure”, 13.7% (n=53) of the respondents stated that they have informed the public about the combined effect of smoking and radon exposure while 86.3% (n=333) of the respondents stated that they have not informed the public about the combined effect of smoking and radon exposure. Of the respondents that informed the public about the combined effect of smoking and radon exposure, 3.9% (n=15) were Health Educators, 4.1% (n=16) were Health Officers, 0.5% (n=2) were Nurses and 5.2% (n=20) were Registered Environmental Health Specialists. Of the

respondents that did not inform the public about the combined effect of smoking and radon exposure, 23.8% (n=92) were Health Educators, 8.8% (n=34) were Health Officers, 25.4% (n=98) were nurse and 28.2% (n=109) were Registered Environmental Health Specialists.

On the question "I have urged members of the public to inform their family about radon", majority of the public health workers in this study stated that they have not urged members of the public to inform their family about radon. 13.5% (n=52) of the respondents have urged members of the public to inform their family about radon while 86.5% ((n=334) have not urged members of the public to inform their family about radon. Of the respondents who have urged members of the public to inform their family about radon, 4.1% (n=16) were Health Educators, 4.1% (n=16) were Health Officers, 0.8% (n=3) were Nurses and 4.4% (n=17) were Registered Environmental Health Specialists. Of the respondents who have not urged members of the public to inform their family about radon, 23.6% (n=91) were Health Educators, 8.8% (n=34) were Health Officers, 25.1% (n=97) were nurses and 29.0% (n=112) were Registered Environmental Health Specialists. Table 8 below summarizes the results concerning public health workers' professional practices about radon gas exposure.

Table 8

Participant Professional Practices about Radon (n=386)

Response	Frequency	Percent
I have informed members of the public about the hazards of radon		
YES	70	18.1
NO	316	81.9
I have urged members of the public to test their homes for radon		
YES	57	14.8
NO	329	85.2
I have informed the public about the combined effect of smoking and radon exposure		
YES	53	13.7
NO	333	86.3
I have urged members of the public to inform their family about radon		
YES	52	13.5
NO	334	86.5

The above test results based on the data collected for this study will be considered in the following paragraphs showing how these data support or challenge the study hypotheses.

Results of Hypotheses Tests

Hypothesis 1a analysis

Research hypothesis 1a posited that there would be significant differences in professional practices about radon gas exposure among public health workers. This first question looked at differences in professional practices among public health workers. Chi-square test of differences (see Table 10) was used to test the differences in professional practices among public health workers. There are independent categorical (nominal; public health workers) and dependent categorical (nominal; professional practices questions score) variables. Data met Chi-square test assumptions of sample size, simple random sampling and independence. The test was calculated comparing the frequency of professional practices questions among public health workers (registered environmental health specialist, health educators, health officers, nurses). A significant outcome was found (x^2 (12) = 58.01, p<.01). This suggests that there are differences in professional practices toward radon gas exposure among public health workers.

Hypothesis 1b analysis

Hypothesis 1b predicted that a relationship would exist between professional practices and knowledge about radon gas exposure among public health workers. Chi-square test of independence (see Table 10) was used to test the relationship between knowledge (nominal) and professional practices (nominal) about radon gas exposure among public health workers. The test was calculated comparing the frequencies of public health worker's knowledge and professional practices questions. A significant outcome was found (x^2 (24) = 69.73, p<.01). This

suggests that there are significant relationships between public health worker's knowledge and their professional practices about radon gas exposure. Cramer's V measure of the strength of association was conducted to measure the strength of association between the two variables, public health worker's knowledge, and their professional practices. A significant Cramer's V of .23, suggests that there is a moderately strong relationship between the variables knowledge and professional practices.

Hypothesis 2a analysis

Hypothesis 2a predicted that a significant difference would exist in knowledge about radon among public health workers. Chi-square test of differences (see Table 10) was used to test the differences in knowledge among public health workers. Answers to knowledge questions are nominal. There are independent categorical (nominal; public health workers) and dependent categorical (nominal; knowledge questions score) variables. The test was calculated comparing the frequency of knowledge questions among public health workers (registered environmental health specialist, health educators, health officers, nurses). A significant outcome was found (x^2 (18) = 94.51, p<.01). This suggests that there are significant differences in knowledge about radon gas exposure among public health workers.

Hypothesis 2b analysis

Hypothesis 2b predicted that a relationship would exist between knowledge and personal practices about radon among public health workers. Chi-square test of independence (see table 10) was used to test relationships between knowledge (nominal) and personal practices (nominal) about radon among public health workers. The test was calculated

comparing the frequencies of public health worker's knowledge and personal practices questions. A significant outcome was found (x^2 (24) = 100.45, p<.01). This suggests that there are significant relationships between public health worker's knowledge and their personal practices about radon gas exposure. A measure of the strength of association between the two variables public health worker's knowledge and their personal practices showed a significant Cramer's V of .25. This suggests that there is a moderately strong relationship between the variables knowledge and professional practices.

Hypothesis 3a analysis

Hypothesis 3a predicted that a significant difference would exist in beliefs about radon gas exposure among public health workers Kruskal-Wallis test (see Table 9) was used to test the differences in beliefs among public health workers. There are independent categorical (nominal; public health workers) and dependent categorical (ordinal; beliefs questions score) variables. A significant outcome was found (H (3) = 19.19, p< .01), indicating that the beliefs about radon gas exposure differed among public health workers. A follow-up pairwise comparisons indicated that Registered Environmental Health Specialists performed significantly better in their responses than the rest of the public health workers regarding their beliefs about radon gas exposure.

Table 9

Independent-Sample Kruskal-Wallis Test of Differences in Beliefs

Total N	386
Test Statistics	19.19
Degrees of Freedom	3
Asymptotic Sig. (2 sided test)	.000

Hypothesis 3b analysis

Hypothesis 3b predicted that a relationship would exist between public health worker's beliefs and their professional practices about radon gas exposure. Chi-square test of independence (see Table 10) was used in testing the relationships between beliefs (ordinal) and professional practices (nominal) about radon among public health workers. The test was calculated comparing the frequencies of public health worker's beliefs and professional practices questions. A significant outcome was found (x^2 (112) = 201.64, p<.01). This suggests that there are significant relationships between public health worker's beliefs and their professional practices about radon gas exposure. A significant Cramer's V of .36, suggests that there is a very strong relationship between the variables belief's and professional practices.

Hypothesis 4a analysis

Hypothesis 4a predicted that a significant difference would exist in the personal practices about radon gas exposure among public health workers. Chi-square test of differences was used (see Table 10) to test the differences in personal practices regarding radon among public health workers. The test consists of the independent categorical variable (nominal; types of public health workers) and dependent categorical variable (nominal; personal practices). The

test was calculated comparing the frequency of personal practices questions among public health workers (registered environmental health specialist, health educators, health officers, nurses). A significant outcome was found (x^2 (12) = 84.75, p<.01). This suggests that there are significant differences in personal practices about radon gas exposure among public health workers.

Hypothesis 4b analysis

Hypothesis 4b predicted that a significant relationship would exist between public health worker's personal practices and their professional practices about radon gas exposure. Chi-square test of independence was used (see Table 10) to test the relationship between personal practices (nominal) and professional practices (nominal) about radon among public health workers. The test was calculated comparing the frequencies of public health worker's personal and professional practices questions. A significant outcome was found (x^2 (16) = 127.09, p<.01). This suggests that there are significant relationships between public health workers personal and their professional practices about radon gas exposure. The measure of the strength of association between the two variables, public health worker's personal and their professional practices was calculated. A significant Cramer's V of .29, suggests that there is a strong relationship between the variables personal and professional practices among public health workers.

Table 10

Summary of Chi-Square Tests of Differences & Independence for Hypotheses (N=386)

Pearson Chi-Square	Value	df	Significance (2-sided)
Ho1a (x^2 test of diff)	58.01	12	.000
Ho1b (x^2 test of indep)	69.73	24	.000
Ho2a (x^2 test of diff)	94.51	18	.000
Ho2b (x^2 test of indep)	100.45	24	.000
Ho3b (x^2 test of indep)	201.64	112	.000
Ho4a (x^2 test of diff)	84.75	12	.000
Ho4b (x^2 test of indep)	127.09	16	.000

Summary

Public health workers that participated in this study had different demographics in relation to their job title, gender, age, education, years practiced in the field, smoking status and residence status. Public health workers' responses to the personal practices questions showed that the majority of public health workers do not know how to test for radon, have not purchased a radon test kit and have not completed a radon test in their homes. Public health workers' responses to the professional practices questions showed that the majority of public health workers have not informed members of the public about the hazards of radon, have not urged members of the public to test for radon and have not informed the public about the combined effect of radon and exposure and smoking. In the analysis section, the study found that here were significant differences in professional practices, knowledge, beliefs and personal practices about radon gas exposure among public health workers. There were significant

relationships between knowledge and professional practices; knowledge and personal practices; beliefs and professional practices; personal and professional practices about radon gas exposure among public health workers.

Chapter V

DISCUSSION

General discussion of key study findings

This study investigated the effects of knowledge, beliefs, personal and professional practices about radon gas exposure among public health workers. The public health workers that responded to the survey were Health Educators, Health Officers, Nurses and Registered Environmental Health Specialists. This study allowed for a direct comparison between public health workers knowledge and their professional practices; public health workers knowledge and personal practices; public health workers beliefs and professional practices; public health workers personal and professional practices about radon gas exposure.

Smoking Status

This study found that majority of public health workers (97.7%) are not current smokers, 42% of public health workers are former smokers and 90.4% have not smoked at least 200 cigarettes in their life. This is an interesting result and it is because public health workers have long known the effects of cigarette smoking and its direct link to lung cancer. Public health workers have helped relay that message to the public about the effects of cigarette smoking and the carcinogenic effect of tobacco. There have been many public health campaigns against tobacco smoking and use for over their years. As such public health workers who have smoked in the past have quit and the new generation of public health workers have not taken up smoking as a hobby. In addition, the rate of smoking in the general public have reduced since

the seventies and it is evident that the number of public health workers who are smokers will also reduce.

Knowledge of Radon gas

This study found that there are differences in the way public health workers understand radon gas exposure. For example, public health workers' responses to the radon knowledge questions varied for health educators, health officers, nurses and registered environmental health specialists that participated in the study. This may be a result of the fact that public health workers are trained differently in their specializations about radon as a health hazard. Public health workers go through in-service training and professional development differently depending on their job area and specialization. This is consistent with NACCHO (2011a, 2011b) and WHO (2006) findings of public health workers coming from different knowledge and academic background with the main purpose of enhancing health within the population they serve. NACCHO (2011a) in describing the local public health workforce as workers who prevent, promote and protect the nation's health, indicated that public health workforce is a collection of individuals from various professional experiences, academic backgrounds, and credentials who unite around the common goal of improving and protecting the health of communities they serve. Job titles in public health are diverse reflecting various knowledge levels.

This study is consistent with Balicer, Omar, Barnett & Everly (2006) findings that public health worker's knowledge gap serves as a barrier to emergency response during a public health emergency. Some public health professionals are training on specific hazards, and many are not cross trained hence a major quagmire arises in an emergency especially if the public

health workers that are familiar with a threat are not available to address the situation hence cross training is vital to the performance of any public health department.

According to NACCHO (2013), public health workers that work in Local Health Departments reply heavily on traditional channels of communication and acquire knowledge through in-service training and professional development based on their area of expertise most not geared towards environmental health. This goes to explain why the public health workers have different environmental health knowledge including radon. Public health workers many times work in silos and have no stated benchmarks that link each of the diverse areas of public health together to produce a cohesive force aligning all disciplines working in public health (NACCHO, 2011b).

Knowledge and Personal Practices

The results from this study found a significant relationship between knowledge and personal practices about radon gas among public health workers. For example, public health workers have knowledge about radon based on their responses to the radon knowledge question. The ability to know and understand a health hazard can affect how a person can move to prevent that health hazard. This is consistent with Abramson, Barkanova & Redden (2014) findings that positive relationships between knowledge and concern about health hazards lead to personal practices of testing for radon. In their study, they examined radon knowledge and concern among an educated middle-income community and found a positive relationship between knowledge and concern. The results of the current study is also consistent with Poortinga, Bronstering & Lannon (2011) findings that the decisions to mitigate

radon gas are either based on a denial that the problem exists or lack of information. Hence radon knowledge is linked to personal practices.

Even though public health workers have differences in their knowledge about radon gas exposure, but still have radon gas exposure knowledge, it did not translate into personal practices about radon gas exposure in this study. 35% of the respondents stated that they know how to test for radon, and 65% stated that they do not know how to test for radon. 12.2% have purchased a radon test kit, and 87.8% have not purchased a radon test kit. 70.2% plan to perform a radon test in their home and 29.8% do not plan to perform radon test in their home. A low number of public health workers (16.3%) have completed a radon test in their home while 83.7% have not completed a radon test in their home. Overall even when public health workers have radon gas exposure knowledge, that did not translate into personal practices of public health workers knowing how to test for radon gas in their homes, purchasing a radon test kit, planning to perform a radon test in their homes or completing a radon test in their homes.

The above results are consistent with Abramson, Barkanova & Redden (2014) findings that when knowledge is high, levels of concern remain low. The current study results are also consistent with previous studies (Duckworth et al, 2002; Wang, Yu, Stark & Teresi, 2000) showing that high awareness of health risks does not essentially result in high concern in the population. In line with the current study findings, many studies have found that healthcare professionals do not practice what they preach in their line of work. Baldwin, Fran & Fielding (1998) surveyed 4,501 female physicians and showed that knowledge of radon gas health risks did not necessarily result in higher radon testing rates. Out of the physicians surveyed, 82% had

not conducted radon screening in their homes although the rate of testing was still 2 to 6 times higher than the general public.

Weinstein, Sandman & Blalock (2008) found that even though radon awareness has been effective in raising the levels of testing, people can have a knowledge of a health hazard or precaution about a hazard without ever having considered whether they need to do anything about it. They believe that this condition of awareness through knowledge without personal engagement is quite common. On a similar study they conducted in a high-risk radon region, respondents stated that they did not think about testing their homes for radon, even though respondents had indicated that they knew what radon was, and most had correctly answered over fifty percent of the questions on a radon knowledge test (Weinstein, Sandman & Roberts, 1991).

The reason why public health workers have radon gas exposure knowledge but still do not test for radon might be because the effects of radon gas exposures are not rapid and acute, but from prolonged exposure making adoption of radon gas testing difficult to accept. Radon being a tasteless, odorless and invisible naturally occuring gas makes testing adoption difficult. Human beings perception to what they can not see and feel would not necessarily be harmful has been a barrier to home radon gas testing. Compared to many environmental health hazards that are visible and could be percieved, people tend to react more to them than radon gas. lAKnowledge of a health hazard does not translate to compliance or action against that health hazard.

Professional Practices about Radon

This study found significant differences in professional practices about radon gas exposure among public health workers. For example, 18.1% of public health workers have informed the public about the hazards of radon. Of the respondents that have informed the public about the hazards of radon, 4.9% (n=19) were Health Educators, 5.4% (n=21) were Health Officers, 0.8% (n=3) were Nurses and 7.0% (n=27) were Registered Environmental Health Specialists. Of the respondents (81.9%) that have not informed the public about the hazards of radon, 22.8% (n=88) were Health Educators, 7.5% (n=29) were Health Officers, 25.1% (n=97) were Nurses, and 26.4% (n=102) were Registered Environmental Health Specialists. This study is consistent with NACCHO, 2011a; NACCHO 2011b findings that public health workers come from various background and perform different tasks in their field of expertise. This also supports the fact that public health workers are diverse in the type and amount of education and training they bring to their work. Job titles are diverse in public health reflecting various professional practices. The results of the current study are also consistent with Gebbie & Turnock (2006) findings of the public health workforce and its new challenges. The public health workforce has been plagued with core competencies issue. Establishing and promoting competencies to describe the expected knowledge, skills and abilities of public health workers faces several challenges. Public health workers come from a variety of professional backgrounds, many of which have their competencies. Each of the public health workers has their specific competency framework that guides their individual profession, and they are diverse and not linked to each other. Example, public health educators use a sophisticated competency framework for their certification in the health education field. This is very different

from the health officers whose competencies are more in the area of health administration and coordinating other professionals in public health to achieve a common goal. Public health nurses, on the other hand, are expected to meet a set of core competencies based on essential public health practices and core nursing professional core competencies; some relate to each other while some are diverse. Registered Environmental Health Specialists competencies are regionally based on environmental issues facing each region or state. Public health professionals in that field will have to take individual state and licensing board exams to practice in each state as not all the states accept the national accreditation from the National Environmental Health Association. These situations make the professional field of public health difficult to navigate hence many public health professionals have different and total views about a public health hazard based on their training and their work specialization. The national public health associations endorsed and adopted a set of competencies to address specific and core public health programs which track the essential public health functions and framework as the basis for assessing and improving the skill of public health workers.

Professional Practices and Knowledge

This study found that there are significant relationships between knowledge and professional practices about radon among public health workers. For example, public health workers have knowledge about radon gas exposure based on their responses to the radon knowledge questions. This shows that public health workers that are responsible for outreach to the communities they serve have to understand radon as a health hazard before they can perform their duties of disseminating radon hazard awareness to the public. This study is

consistent with Hazar et al. (2014) findings that education of healthcare professionals is a precursor to public campaigns on radon awareness and testing. In that study conducted among healthcare providers, they also found that perceiving and having knowledge about radon as a risk had a significant association with willingness to take appropriate health-related behaviors and informing the public about the hazards of radon. They also found that willingness to test for radon gas in the homes of the healthcare workers does not translate into informing the public about the hazards of radon as part of their professional practices.

Results of the current study, show that knowledge about radon gas exposure among public health workers does not translate into professional practices of radon gas exposure among public health workers. Even though public health workers had knowledge about the hazards of radon gas exposure, it did not translate into professional practices of informing the public and creating public awareness as part of their job responsibilities. In this study, 18.1% of the respondents have informed members of the public about the hazards of radon gas exposure as part of their professional practices as public health workers and 81.9% have not informed the public about radon gas hazards. 14.8% of the respondents have urged members of the public to test their homes for radon while 85.2% have urged the public to test for radon gas in their homes as part of the professional practices as public health workers. 13.7% of the respondents have informed the public about the combined effect of smoking and radon exposure while 86.3% of the respondents have not informed the public about the combined effects of smoking and radon exposure as part of their professional practices as public health workers. 13.5% of the respondents have urged members of the public to inform their family

about radon as part of their professional practices as public health workers while 86.5% have not urged members of the public to inform their family about radon gas hazard.

Knowledge about health hazards has to translate into professional practices to make sense and for the public to understand the health risks involved in ignoring a potential health hazard. Schlafer, McRee, Grower & Bearinger (2016) found that health programs such as internships and fellowship programs geared towards acquiring knowledge about health hazards and better communication to the public invest heavily in teaching skills for conducting research and health education and promotion. These programs and skills acquired are not enough to focus on how to translate the scientific evidence into practice, programs, and policy. WHO (2007) in its publication about putting cancer control knowledge into action, suggested that the knowledge of cancer-causing agents and precursors should be widely made known to the public through healthcare professionals including public health workers. For this goal to be achieved public health workers will have to translate their knowledge of cancers causing agents into professional practices of informing the public about the need for example home radon testing including informing members of the public about the hazards of radon gas exposure, urging members of the public to test their homes for radon gas, informing the public about the synergistic effect of smoking and radon gas exposure and urging members of the public to inform their family about radon gas exposure both in their workplace and abode.

The reason why public health workers professional practices about radon gas exposure is low in this study might be because some public health workers may be viewing the job of public outreach to be limited to only some workers, those with a certain title. Some respondents especially those that do not have job titles of health education and promotion may

not have any idea that being a public health worker, they are regarded as change agents. These public health workers do not understand that their job responsibilities include reaching out to the public about health issues especially environmental health hazards such as radon gas exposure.

Beliefs about radon

This study found a significant difference in beliefs about radon gas exposure among public health workers. Kruskal-Wallis test was used to test the differences in beliefs among public health workers. A follow-up pairwise comparisons indicated that Registered Environmental Health Specialists performed significantly better in their responses than the rest of the public health workers regarding their beliefs about radon gas exposure.

The results of the current study finding is consistent with NACCHO, 2011a; NACCHO, 2011b and WHO (2006). The public health profession has been trying to create a benchmark by which public health workers could be trained in the essential public health services as part of their duty to serve the public. Beliefs are formed from experiences through various aspects of life including professional experiences acquired through knowledge. Public health services and prevention efforts are carried out by the Local Health Departments across the United States, directly and indirectly, affect the daily lives of individuals and community. As public health workers interact with the public, they bring about their beliefs in health hazards. Public health worker's beliefs reflect their attitude and how they carry out their daily activities and what they believe in translates to how they effectively communicate potential health hazards to the public.

This current study finding is in line with Terpstra, Lindell & Gutteling (2009) which suggests that people have differences in belief based on their knowledge of a hazard. They reported that personal experience with hazard adjustments increases adoption intentions by providing more rich and detailed information and lower levels of uncertainty. Secondhand experience with either a hazard, knowledge of a hazard or hazard modifications can also affect people's protection motivation and hazard modification adoption in the same ways as direct experience (Lindell & Prater, 2002; Terpstra, Lindell & Gutteling, 2009). Some studies not related to radon have linked high beliefs scores to personal practices about health hazards, but that is not the case in this study. Even though public health workers had high beliefs scores about the potentials of radon gas as a health hazard, this study found that it did not translate into personal practices of public health workers engaging in behaviors such as testing their homes for radon gas exposure, buying radon test kits, knowing how to test for radon and planning to test for radon gas exposure.

The reason why public health workers' beliefs are different might be because public health workers come from various background and go through various professional training where they pick up knowledge about radon gas exposure. Public health workers form their beliefs based on their professional training and beliefs about the hazards they studied and how these hazards are presented to them during training. Another reason is that radon being a tasteless, odorless and invisible naturally occuring gas makes belief adoption difficult. Naturally human beings believe that what can not be seen and felt would not necessarily be harmful. Compared to many environmental health hazards that are visible and could be percieved, people tend to react more to them than radon gas. The reason why public health workers'

beliefs do not translate into personal practices might also be tied to the diversity of professions in public health where beliefs are formed from knowledge and hence determine personal practices.

Beliefs and Professional Practices

The relationships between beliefs and professional practices about radon gas exposure among public health workers were found to be significant. For example, public health workers believe that living with radon gas could result in a serious health problems and that mitigation of radon in homes could save lives. Public health workers with job responsibilities of public outreach have knowledge and understanding about radon gas exposure as part of their training and job responsibilities. Their beliefs about radon gas hazards lead to professional practices. Even though this study found that there are differences in public health worker's beliefs about radon gas exposure as a public health hazard, public health workers agree that there are relationships between beliefs and how it translates into professional practices. This finding is consistent with Fitz-Patrick et al. (2010) finding that there is a connection between risk perception and risk communication. The way public health workers perceive risk as in their beliefs translates into communicating that risk to the public. This study finding is also consistent with Terpstra, Lindell & Gutteling (2009) findings that beliefs have important implications for risk communication. Essentially public health workers communicate what they believe to be the truth and what they believe in and have a knowledge of the subject matter.

In this study, public health workers both agreed and strongly agreed (92%) that living with radon exposure greater than 4 picocuries per liter could result in serious health problems for them. 78.1% of public health workers both agreed and strongly agreed that they are worried

about radon causing illness in them. 78.5% of public health workers agreed and strongly agreed that there is a real chance that they could have a radon problem in their homes. 90.7% of public health workers agreed and strongly agreed that mitigation of radon in their homes could save lives. 82.4% of public health workers agreed and strongly agreed that they believe that radon is likely to be present in the homes in their neighborhood. 87.8% of public health workers agreed and strongly agreed that they are worried about causing illness to the public that they serve. 98.4% of public health workers agreed and strongly agreed that the health risk from the combination of smoking and radon is much greater than from either of them alone. 98.2% of public health workers agreed and strongly agreed that if there is radon in their home, then it is a health risk to them. 99.2% of public health workers agreed and strongly agreed that if there is radon in their homes, then it is a health risk to others living with them. 97.6% of public health workers agreed and strongly agreed that they believe that the health risk from the combination of second-hand smoke and radon is much greater than from either of those alone. 80.8% of public health workers agreed and strongly agreed that reducing radon levels in homes helps prevent disease. Finally, and surprisingly 23.5% of public health workers agreed and strongly agreed that they believe that they have sufficient knowledge about radon to be a change agent in their community. The above response from public health workers excluding the last response shows that public health workers have a high belief response to the radon gas exposure belief scale. However, this high belief did not translate into professional practices as majority of public health workers did not inform members of the public about hazards of radon, did not urge members of the public to test their homes for radon, did not inform the public about the

combined effect of smoking and radon gas exposure and did not urge members of the public to inform their family about radon gas.

The reason why public health workers' beliefs do not translate into professional practices might be that public health workers do not feel that they have sufficient knowledge which forms beliefs. Public health worker's inability to perform well or reach out to the public as part of their job as practicing public health professional manifested in their response to the last belief scale question. When asked "Do you have sufficient knowledge about radon gas to be a change agent in the community", public health workers disagreed, strongly disagreed or neutral (76.5%) that they do not have sufficient knowledge about radon to be a change agent in the community. It might also be that public health workers' diverse backgrounds based on their different professional trainings makes it difficult for public health workers to translate their beliefs acquired through training and knowledge to professional practices of reaching out to the public about the hazards of radon gas exposure.

Personal and Professional Practices

This study found that there are there are significant relationships between public health workers personal and professional practices about radon gas exposure. For example, public health workers agree that they do not know how to test for radon as part of their personal practices and have not informed the members of the public about the hazards of radon gas exposure as part of their professional practices. Public health workers with job responsibilities of outreaching to the public have personal practices formed from their knowledge and understanding about radon gas exposure as part of their training and their professional

practices of reaching out to the public. This is consistent with Balicer, Omar, Barnett & Everly (2006) findings that public health workers response rate are higher during public health emergencies if they perceive and link imminent hazards to their role as public health professionals and hence willing to come out in during public health emergency. This study finding reflects and is consistent with Moyo et al. (2016) finding that professional and personal values of healthcare practitioners influence their clinical decisions. In their study about health care practitioners personal and professional value, they suggested that understanding the values for individuals in the healthcare settings and across healthcare professions can help improve patient-centered decision making by the various practitioner's inter-professional teams.

The result of the current study found that the responses to both the personal and professional practices questions are similar. In the personal practices questions, the majority of the public health workers do not know how to test for radon, have not purchased a radon test kit, do not plan to perform radon test in their homes and have not completed a radon test in their homes. In the professional practices questions, the majority of public health workers did not inform members of the public about the hazards of radon gas exposure, did not urge members of the public to test their homes for radon gas, did not inform the public about the combined effect of smoking and radon exposure and did not urge members of the public to inform their family about the health hazards of radon gas exposure.

The reason why personal and professional practices are related in this study might be that most public health health workers are in agreement that they do not know how to test for radon, did not test their homes for radon, did not buy a radon test kit as part of personal

practices and did not inform members of the public about the hazrds of radon, did not urge members of the public to test their homes for radon, did not inform the public about the combined effect of smoking and radon exposure and did not urge members pof the public to inform their family about radon gas exposure hazards as part of their job responsibilities and professional practices of reaching out to the public about radon gas exposure. Another reason is that it is hard to preach what on do not practice. It is difficult to sell a product that one do not know how to operate. When a public health worker do not test for radon in their homes and have not purchased a radon test kit, it is difficult for that public health worker to go out in the public and inform members of the public about radon testing while that person has not tested their homes for radon. If a question arise while perfroming health promotion about radon gas testing, the public health worker who do not know how to test for radon will have no answer and hence cannot perform an effective radon health promotion without first knowing how to use a tool required for health promotion.

Conceptual Framework Revisited

This study investigated the effects of knowledge, beliefs, personal and professional practices about radon gas exposure among public health workers. The study measures were centered around constructs emergent from the Precaution Adoption Process Model (PAPM). Recall that this study utilized PAPM a stage theory originally developed to describe the process by which people adopt precaution to what they recently learned, rather than information they have been aware of for some time (Weinstein, 1988). PAPM seeks to identify all stages that are involved when people start a health behavior and what factors determine their movement from

one stage to another before they act or change a behavior or make a decision. Knowing the results of this study allows for viewing the original conceptual framework as it fits the result of the study.

The current PAPM identifies seven stages along the path from lack of awareness to action (see Figure 5) and this appears to explain how public health workers relate to the issue of radon gas exposure. At some initial point in time, public health workers are unaware of the health issue being radon gas exposure (Stage 1). When public health workers first learn something about radon gas exposure, they are no longer unaware, but they are not yet engaged by it either (Stage 2). Public health workers who reach the decision-making stage (Stage 3) have become engaged by the issue and are considering their response. This decision-making process can result in one of three outcomes: They may suspend judgment (testing for radon gas), remaining in Stage 3 for the moment. They may decide to take no action, moving to Stage 4 and halting the precaution adoption process, at least for the time being. Or, they may decide to adopt the precaution, moving to Stage 5. For public health workers who decide to adopt the precaution by testing for radon gas in their homes, the next step is to initiate the behavior (Stage 6). A seventh stage, indicates that the behavior has been maintained over time and public health workers may now be able to communicate radon gas exposure hazard to the communities they serve (Stage 7). The result of this study did not fit into the PAPM conceptual framework that allows public health workers to go through stages or adoption of learning about radon, purchasing a radon test kit, testing their homes for radon and reaching out to the public about the hazards of radon gas exposure as part of their job responsibilities. This study found that for most public health workers PAPM stage 2 did not translate into stage 4 as public health

workers had the knowledge and belief about radon gas exposure but it did not translate into testing their homes for radon gas exposure (personal practices) or reaching out to the public as part of their job responsibilities (professional practices) (see Figure 6). The PAPM however, can be a good tool and used by public health workers while reaching out to the public as change agents and providing health education and health promotion activities about radon gas exposure.

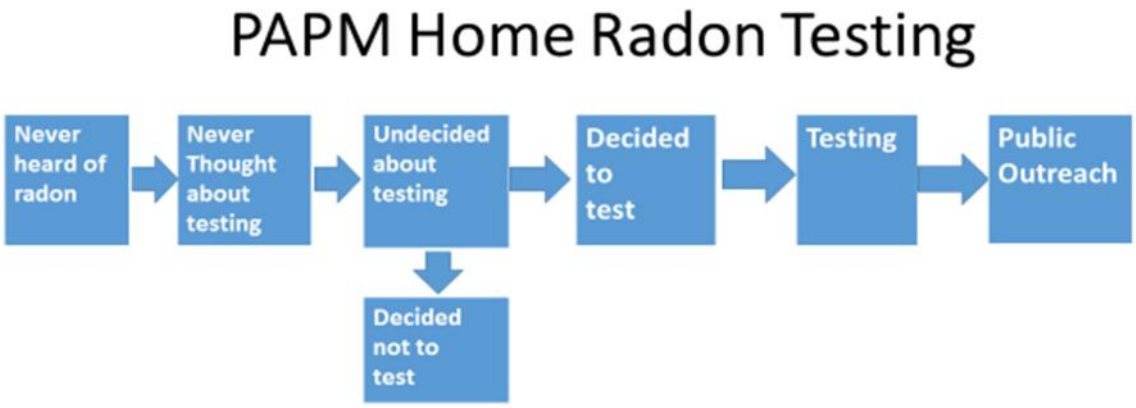

Figure 5. Stages of Radon Precaution Adoption Process Model

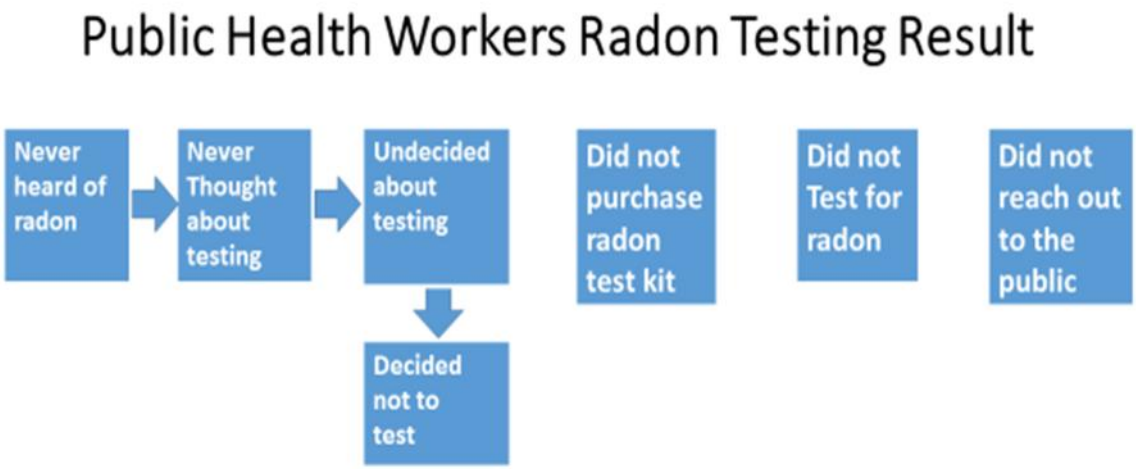

Figure 6. Public Health Workers Radon Testing Result

Policy and Practice Implications

The role of public health workers as change agents in the community and the first line of defense in the community they serve has been well established and documented. Exploring knowledge, beliefs, personal and professional practices of radon gas exposure among public health workers provides a baseline to further train public health workers about environmental hazards and create more awareness in the public. This study hopes to provide guidance that will enable institutions of higher learning to include knowledge of environmental hazards in the curriculum of environmental health professionals. Public health workers need to go through training knowing that change based on foundational knowledge is essential for behavior

change. Foundational knowledge, belief and practices about radon gas should be used to create training for public health workers.

Competency based training is required for public health workers to be in line with the dictates of the profession they represent in the field of public health. Public health workers should have knowledge about radon gas exposure and reach out to the public as part of their professional practices of disseminating what they know to the communities they serve. According to NACCHO (2013) public health professionals have taken various approaches to credentialing that include licenses (nurses, health officers), certifications (health educators) and registrations (registered environmental health specialists). Competency based training of all public health workers should include a segment of environmental health hazard including radon gas hazards. Public health workers should be part of periodic internal assessment in Public Health Departments. Periodic internal assessment should be part of a radon awareness programs in public health departments to ascertain the level of knowledge, beliefs and practices of radon gas exposure among all public health workers.

Public Outreach Programs: Public education about potential health hazard is the key to preventing and control of potential public health hazards. Yearly fire departments in each community engage in public announcements and information campaigns about testing fire alarms and carbon monoxide detectors. However, none of these programs are geared towards home radon detection because the effect pf radon is not imminent but build over time. The public health department should be tasked with efforts to have such programs and campaigns around the same time of the year when fire department creates awareness in the public about

fire alarms and dangers of carbon monoxide build up in homes. Radon gas should be treated the same and given the same publicity as fire alarms and smoke detectors.

This study has shown that even though public health workers have differences in their knowledge, beliefs, personal and professional practices about radon gas exposure, they have relationships in how they responded to the knowledge and professional practices questions, knowledge and personal practices questions, beliefs and professional practices questions, personal and professional practices questions about radon gas exposure. Further, public health worker's high response on the radon gas exposure knowledge and belief scale did not translate into their engaging in personal and professional practices about radon gas hazard.

Public health administrators should be made responsible for ensuring that public health workers especially those with job titles of disseminating awareness of public health hazards to the community perform their professional practices role of radon gas exposure knowledge in the communities they serve. Funds set aside for this effort should be provided to local health department for radon public campaign initiatives.

Public education about potential health hazard is the key to preventing and control of potential public health hazards. Yearly fire departments in each community engage in public announcements and information campaigns about testing fire alarms and carbon monoxide detectors. However, none of these programs are geared towards home radon detection because the effect pf radon is not imminent but build over time. The public health department should be tasked with efforts to have such programs and campaigns around the same time of the year when fire department creates awareness in the public about fire alarms and dangers

of carbon monoxide build up in homes. Radon gas should be treated the same and given the same publicity as fire alarms and smoke detectors.

Previous studies have shown that hazards prevention are better adopted if the government is involved in disseminating such hazards (Weinstein, Sandman & Roberts, 1991). Most public health departments do not have radon awareness programs as part of their public health hazard notification and awareness campaigns in the communities they serve. The effects of radon gas exposure and its cancer causing abilities should be made paramount to all public health workers. State governments through their state health department should make it a priority to inform local health departments and make local health department send annual reports showing their involvement in radon community outreach. State Department of Environmental Protection should take the lead and provide tools and materials that local health departments need to provide successful public radon gas exposure outreach in the community.

Study Limitations

There were some limitations to this study. This is a correlational study and cannot provide a clear reason why there is a relationship between knowledge and professional practices; knowledge and personal practices; beliefs and professional practices; professional and personal practices about radon among public health workers. Correlation does not denote causation but could provide great insight. There might be a possibility of a third unknown variable that might have contributed to the correlation. This study is cross-sectional in nature as the sample was surveyed at a single time. It is difficult to determine temporal relationships

between exposure and outcome. This study was performed in New Jersey, and generalizability of findings is limited to the sample surveyed.

Further, this study surveyed all public health workers working for public health departments in New Jersey. Not all public health workers are trained or know how to provide outreach to the community they live or serve as part of their professional practice. In fairness, it is hard for all public health workers to answer questions regarding professional practices because not all of them has job duties related to public outreach or educating the public about health issues and health hazards.

This study utilized self-reported data from respondents to identify relationships and differences between scores on the variable that the scale is measured. It has its advantages as it is a cheap way of obtaining data, easily implemented to large samples and can be used to measure constructs that would be difficult to obtain. However, it is wholly dependent on the honesty of the respondents to provide accurate answers to the scale questions. Answers to study questions depend on respondent's personality. There might be an issue with response bias where study participants tend to respond a certain way regardless of the actual evidence they are assessing. Respondents might see themselves completely different from their answer to the survey question. In that case, any self-reported information may be incorrect despite principal investigator's efforts to retrieve accurate information from the respondents.

There might be an issue with control of sample. This study utilized Survey Monkey to gather data from public health workers. Some respondents might want clarifications on some questions but could not because the survey was online. There might be an issue with the

language of the scale even though the scale instruction was made simple for respondents to understand. Language of the scale items might be ambiguous. People interpret and use scales differently, and that could be a problem when respondents take different scale item during a short period.

It should be noted that this study was performed in NJ alone. Geographical location of respondents in NJ could not be verified. Respondents self-reported the data. This study is not generalizable beyond the participants.

Finally, this survey was conducted via Survey Monkey, and the link was provided to participants electronically via email. Therefore, the study may have excluded those public health workers that do not have access to emails during the duration of the survey.

Directions for future research

Longitudinal studies should be performed on the knowledge, beliefs, personal and professional practices about radon gas exposure among public health workers to ascertain if public health worker's responses changed over time. It would be very interesting to know if public health worker's knowledge and beliefs translate into their personal and professional practices about radon gas exposure.

A country-wide study should be performed on this topic since radon gas exposure hazard is not only a problem in New Jersey but across the entire United States. Even though public health workers have a similar work structure and job titles geographically across the country, their knowledge, beliefs, personal and professional practices should be interesting to

know. In addition, the outcome of the national study should dictate the role of public health workers in future radon gas public campaign initiative.

A geographic information system (GIS) study of respondents should be performed to know where the study participants come from and know if their knowledge is linked to areas of high radon gas accumulation. It will also be interesting to know if survey responses from areas of high radon prevalence differ from respondents that live and work in areas of low radon prevalence compared to areas without radon gas exposure in their environment. This will be vital in mapping out radon gas campaign in areas of high radon gas prevalence and finding programs geared towards prevention and awareness in areas with low or no radon gas build up.

Future study should be geared toward public health workers with job responsibility of community outreach. Some public health titles do not require public health workers to interact with the community and their role in radon gas exposure professional practices is limited to public outreach via phone calls, emails, and telephones. However, for those with job responsibilities of public outreach, they mingle in the public and make home visits, engaging in activities that will create awareness about public health hazards.

Finally, logistic regression model should be utilized for future studies to understand the effect of other variables that could not be identified using Chi-square analysis and how they played a role in the study outcomes.

Conclusion

In concluding, this study investigated a number of several gaps in the literature regarding public health workers' radon knowledge, belief, personal and professional practices about radon gas exposure. Public health workers have always been used and perceived as the protector of the health rights of the poor and the underserved members of the public. Though the literature identified some of the thematic factors under study, no study has looked at what public health workers are doing regarding radon awareness in the public and ascertain whether public health workers are capable of being utilized as change agents to perform public outreach activities in the community they serve in the area of disseminating awareness radon gas exposure hazard and urging the public to test for radon gas in their homes. This study surveyed public health workers working in health departments across New Jersey to be familiar with their ability to perform professional practices of reaching out to the public about radon gas exposure. While looking at public health worker's professional practices, their personal practices about testing for radon in their homes were studied. Also, this study looked at whether public health workers have knowledge about radon gas and their beliefs about radon gas exposure. This study was able to posit that even though public health workers have the knowledge and high beliefs about radon gas exposure that did not translate into personal practices of protecting themselves and their families from radon gas exposure or professional practices of informing the public about radon gas exposure as part of their job responsibility. The information gained from this study will, hopefully, help policy makers and government agencies create and formulate programs that are geared towards reaching out to public health workers and aligning them to be change agents that they are by providing them with tools to

reach out to the communities they serve through initiating radon gas awareness and testing in those communities.

References

Abrams, S., & Hays, J. (2006). Environmental health nursing. *Public Health Nursing, 23(5, Special Issue),* 377–483.

Abramson, Z., Barkanova, S., & Redden, A.M. (2014). Concerning knowledge: Assessing radon knowledge and concern in rural Nova Scotia. *The Journal of Rural and Community Development, 9*(2), 103-111.

Agency for Toxic Substances and Disease Registry, Centers for Disease Control and Prevention. (2008). A primer on health risk communication*: Principles and practices—overview of issues and guiding principles.* Retrieved October 26, 2012, from http://www.atsdr.cdc.gov/risk/riskprimer/vision.html

Al Zabadi, H., Musmar, S., Issa, S., Dwaikat, N., & Saffarini, G. (2012). Exposure assessment of radon in the drinking water supplies: A descriptive study in Palestine. *Bio Medical Central 5,* 29

Baban, A., & Craciu, C. (2007). Changing health risk behavior: A review of theory and evidence based interventions in health psychology. *Journal of Cognitive & Behavioral Psychotherapies Vol.* 7 no. 1.

Baldwin, G., Frank, E., & Fielding, B. (1998). U.S. women physicians' residential radon testing practices. *American Journal of Preventive Medicine,15*(1) 49-53.

Balicer, D. R., Omer, B. S., Barnett, D.J., & Everly Jr, G.S. (2006). Local public health workers perceptions toward responding to an influenza pandemic. *Bio Med Central Public Health* 6(99) 1-8.

Bier, V. (2001). On the state of the art: Risk communication to the public. *Reliability Engineering & System Safety, 71*:139-150.

Beir, V. I. (1999). Committee on Health Risks of Exposure to Radon. Health effects of exposure to radon.

Bongaarts, J. (2006). World Health Organization: Working together for health: The world health report 2006. *Population and Development Review 32*(4), 790-792.

Butterfield, P. (2002). Upstream reflections on environmental health: An abbreviated history and framework for action. *Advances in Nursing Science, 25,* 32–49.

Clark, M.A., Rakowski, W., Ehrich, B., Rimer, B.K., Velicer, W.F., Dube, C.E.,..Goldstein, M. (2002). The effect of a stage-matched and tailored intervention on repeat mammography. *American Journal of Prev. Medicine, 22,* 1–7.

Clarkson, T. W., & Magos, L. (2006). The toxicology of mercury and its chemical compounds. *Critical Reviews in Toxicology, 36,* 609–662.

Cohrssen, J. J., & Covello, V. T. (1989). *Risk analysis: A guide to principles and methods for analyzing health and environmental risks.* Springfield, VA: U.S.

Darby, S. (2005). Radon in homes and risk of lung cancer: collaborative analysis of individual data from 13 European case-control studies. *British Medical Journal; 330*(7485), 223-227.

DeAscentis, J. L., & Graham, J. D. (1998). Ranking risks in the home. *Risk in Perspective, 6*(4), 1-4.

Desvousges, W. H., Smith, V. K., & Rink, H.H. (1992). Communicating radon risks effectively: The Maryland experience. *Journal of Public Policy and Marketing 2,* 68-78.

Dixon, K., Hendrickson, K., Ercolano, E., Quackenbush, R., & Dixon, J. (2009). The Environmental Health Engagement Profile: What People Think and Do About Environmental Health. *Public Health Nursing Vol. 26 No.* 5, pp. 460–473.

Dixon, J. K. (2002). Kids need clean air: Air pollution and children's health. *Family and Community Health, 24,* 9–26.

Dixon, J. K., & Dixon, J. P. (2002). An integrative model for environmental health research. *Advances in Nursing Science, 24,* 43–57.

Duckworth, L. (2002). Relationship of perception of radon as a health risk and willingness to engage in radon testing and mitigation. *Oncology Nursing Forum 29*(7)1099-1107.

Eagly, A.H., & Chaiken, S. (1993). *The Psychology of Attitudes.* Fort Worth, TX: Harcourt Brace.

Fazio, R. H. (2007). Attitudes as object-evaluation associations of varying strength. *Social Cognition, 25*(5), 603.

Fazio, R. H., & Zanna, M. P. (1981). *Direct experience and attitude behavior consistency. Pp. 161–202 in Berkowitz L (ed). Advances in Experimental Social Psychology*. San Diego, CA: Academic Press.

Field, R. W. (2010). Environmental Factors in Cancer: Radon, *Reviews on Environmental Health - Special Edition (Part 2), 25* (1), 25-31, PMCID.

Fisher, J.D., Fisher, W.A., Bryan, A.D., & Misovich, S.J. (2002). Information-motivation behavioral skills model-based HIV risk behavior change intervention for inner-city high school youth. *Health Psychology, 21,* 177–186.

Fitzpatrick-Lewis, D., Yost, J., Ciliska, D., & Krishnarante, S. (2010). Communication about environmental health risks: A systematic review. *Journal of Environmental Health 9:*67

Fleisher, R. L., Giard, W.R., Mogro-Campero, A., Turner, L.G., Alter, H.W., & Gingrich, J.E. (1980). Dosometry of environmental radon: methods and theory of low dose, integrated measurements. *Health Physiology, 9*:957.

Floyd, D. L., Prentice-Dunn, S., & Rogers, R.W. (2000). A meta-analysis of research on protection motivation theory. *Journal of Applied Social Psychology, 30*(2):407–429.

Food and Agriculture Organization of the United Nations & World Health Organization (1995). [http://www.who.int/foodsafety/publications/micro/en/march1995.pdf], Accessed July 2010.

Gebbie, K. M., & Turnock, B. J. (2006). The public health workforce, 2006: new challenges. *Health Affairs, 25*(4), 923-933.

George, D., & Mallery, M. (2003). *Using SPSS for Windows step by step: a simple guide and reference.* Boston, MA: Allyn & Bacon.

Glassman, L.R., & Albarracin, D. (2006). Forming attitudes that predict future behavior: A meta-analysis of the attitude-behavior relation. *Psychological Bulletin, 132*, 778–822.

Halpern, M. T., & Warner, K. E. (1994). Radon risk perception and testing: Sociodemographic correlates. *Journal of Environmental Health, 56*(7), 31.

Hampson, S. E., Andrews, J. A., Barckley, M., Lichtenstein, E., & Lee, M. E. (2006). Personality traits, perceived risk, and risk-reduction behaviors: a further study of smoking and radon. *Health Psychology, 25*(4), 530.

Hancock, T. (2002). Indicators of environmental health in the urban setting. *Canadian Journal of Public Health, 93*(Suppl. 1), S45–S51.

Harris, P. (1996). Sufficient grounds for optimism? The relationship between perceived controllability and optimistic bias. *Journal of Social and Clinical Psychology, 15*(1), 9–52.

Hasson, F., Keeney, S., & McKenna, H. (2000). Research guidelines for the Delphi survey technique. *Journal of advanced Nursing, 32*(4), 1008-1015.

Hill, W., Butter, P., & Larsson, L. (2006). Rural parents perception of risks associated with their children's exposure to radon. *Public Health Nursing Vol. 23* No. 5, pp. 392-399.

International Agency for Research on Cancer (1988). Man-made mineral fibres and radon. *IARC Monogr Eval Carcinog Risks Hum*, *43*, 1–300.

Institute of Medicine (1995). Committee report on enhancing environmental health content in nursing practice: *Nursing, health and the environment.* Washington D.C.: National Academy Press.

Institute of Medicine (1988). Future of public health. Washington D.C : National Academy Press.

Isenberg, J. D. (1986). Group polarization: A critical review and meta analysis. *Journal of Personality and Social Psychology, 50* (6), 1141–1151.

Johnston, D. (1999). Volcanic hazard perceptions: Comparative shifts in knowledge and risk. *Disaster Prevention and Management, 8* (2), 118–126.

Keller, C., Siegrist, M., & Visschers, V. (2009). Effect of risk ladder format on risk perception in high and low level numerate individuals. *Risk Analysis, vol.29*, no. 9,

Kennedy, C. J., Probart, C. K., & Dorman, S. M. (1991). The relationship between radon knowledge, concern and behavior, and health values, health locus of control and preventive health behaviors. *Health Education & Behavior, 18*(3),319-329.

Klepeis, N., Tsang, A., & Behar, J. (1996) Analysis of the National Human Activity Pattern Survey (NHAPS) respondents from a standpoint of exposure assessment. Washington, DC: U.S. Environmental Protection Agency.

Klepeis, N. E., Nelson, W. C., Ott, W. R., Robinson, J. P., Tsang, A. M., Switzer, P., ... & Engelmann, W. H. (2001). The National Human Activity Pattern Survey (NHAPS): a resource for assessing exposure to environmental pollutants. *Journal of exposure analysis and environmental epidemiology*, *11*(3), 231-252.

Krewski, D., Lubin, J. H., Zielinski, J. M., Alavanja, M., Catalan, V. S., Field, R.W., … & Sandler, D.P. (2005). Residential Radon and Risk of Lung Cancer: A Combined Analysis of 7 North American Case-Control Studies. *Epidemiology, 16*(2),137-145.

Lanphear, B. P., Hornung, R., Khoury, J., Yolton, K., Baghurst, P., & Bellinger, D. C. (2005). Low level environmental lead exposure and children's intellectual function: An international pooled analysis. *Environmental Health Perspectives, 113,* 894–899.

Leep, C. J. (2006). 2005 national profile of local health departments. *Journal of Health Management Practice, 12*(5), 496-498.

Levy, J. I., Hammitt, J. K., & Spengler, J. D. (2000). Estimating the mortality impacts of particulate matter: What can be learned from between study variability? *Environmental Health Perspectives,108,* 109–117.

Lidsky, T. I., & Schneider, J. S. (2003). Lead neurotoxicity in children: Basic mechanisms and clinical correlates. *Brain, 126,* 5–19.

Lindell, M.K, & Perry, R.W. (2004). *Communicating environmental risk in multiethnic communities.* Thousand Oaks, California: Sage Publications.

Lindell, M.K, & Perry, R.W. (1991). Understanding evacuation behavior: An editorial introduction. *International Journal of Mass Emergencies and Disasters, 9,* 133–136.

Lindell, M.K, Prater, C. S (2002). Risk area residents' perceptions and adoption of seismic hazard adjustments. *Journal of Applied Social Psychology, 32*(11):2377–2392.

Linstone, H. A., & Turoff, M. (Eds). (1975). *The Delphi method: Techniques and applications* (Vol. 29). Reading, MA: Addison-Wesley.

Lipkus, I. (2007). Numeric, verbal and visual formats of conveying health risks: Suggested best practices and future recommendations. *Medical Decision making, 27*, 696-713

Lipkus, I., & Holland, J. (1999). The visual communication of risk. *Journal of the National Cancer Institute Monographs, 25*, 149-163.

Liu, W., Zhang, J., Korn, L., Weisel, C., Turpin, B., Morandi, M., Stock, T., & Colome, S. (2007). Predicting personal exposures to airborne carbonyls using residential measurements and time/ activity data. *Amos Environment, 41, 5280-8*

Lubin, J.H., Wang, Z. Y., Wang, L. D., Boice, J. D., Cui, H. X., Zhang, S. R., ….Kleinerman, R. A. (2005). Adjusting lung cancer risks for temporal and spatial variations in radon concentration in Dwellings in Gansu Province China*. Radiation Research Journal, 163*, 571-579.

Marcinowski, F., Lucas, R. M., & Yeager, W.M. (1994). National and regional distributions of airborne radon concentrations in U. S. homes. *Health Physics Journal* 66*,* 699-706.

Mendez, D., Alshanqeety, O., Warner, K. E., Lantz, P. M., & Courant, P. N. (2011). The impact of declining smoking -radon related lung cancer in the United States. *American Journal of Public Health, 101*(2), 310-314.

Migneault, J. P., Velicer, W.F., Prochaska, J.O., & Stevenson, J. F. (1999). Decisional balance for immoderate drinking in college students. *Substance Use and Misuse, 34*, 1325–1346.

National Association of County and City Health Officials. (2011a). *Describing the local public health workforce: workers who prevent, promote, and protect the nation's health.* Washington, DC. Available at http://naccho.org/uploads/downloadable-resources /Describing-the-Local-Public-Health-Workforce-Workers-who-Prevent-Promote-and -Protect-the Nations-health.pdf Accessed May 20, 2015.

National Association of County and City Health Officials. (2011b). *Local public health workforce benchmarks.* Washington, DC. Available at http://naccho.org/uploads/downloadable-resources/local-public-health-workforce-staffing-benchmarks.pdf Accessed May 20, 2015.

National Association of County and City Health Officials. (2013). *2013 national profile of local health departments report.* Washington, DC. Available at http://naccho.org/uploads/ downloadable-resources/2013-national-profile-of-local-health-departments-report.pdf Accessed August 22, 2016.

National Research Council (1988). *Health risks of radon and other internally deposited alpha-emitters: (NRC BIER IV.)* Washington DC: National Academy Press.

National Research Council (1999). *Health effects of exposure to radon: Committee on health risks of exposure to radon. (NRC BIER VI)* Board on radon effects research. Washington DC: National Academy Press.

Neuwirth, K., Dunwoody, S., & Griffin, R. J. (2000). Protection motivation and risk communication. *Risk Analysis, 20*(5), 721–734.

Odedina, F. T., Warrick, C., Vilme, H., & Young, S. (2008). Pharmacists as health educators and risk communicators in the early detection of prostate cancer. *Journal of Social Administrative Pharmacy, 4*(1), 59-66.

Ott, W. (1989). Human activity patterns: A review of the literature for estimating time spent indoors, outdoors and in transit. Las Vegas, NV: U.S. Environmental Protection Agency National Exposure Research Laboratory.

Peters, E (2008). Numeracy and the perception and communication of risk. *Annals of the New York Academy of Sciences, 1128*, 1-7.

Petty, R.E., & Krosnick, J.A. (1995). *Attitude Strength: Antecedents and Consequences.* Mahwah, NJ: Lawrence Erlbaum.

Petty, R. E., Wheeler, S. C., & Tormala, Z. L. (2003). Persuasion and attitude change. In T. Millon & M. J. Lerner (Eds.), *Handbook of psychology,* Vol. 5: *Personality and social psychology* (pp. 353–382). Hoboken, NJ: John Wiley.

Persky, V., Turyk, M., Piorkowski, J., Cover, L., Knight, J., & Wagner, C. (2007). Inner city asthma: The role of the community. *Chest, 132(Suppl.),* 831S–839S.

Plummer, B.A., Velicer,W.F., Redding, C.A., Prochaska, J.O., Rossi, J.S., Pallonen, U.E., & Meier, K.S. (2001). Stage of change, decisional balance, and temptations for smoking. Measurement and validation in a large, school-based population of adolescents. *Addictive Behaviors, 26,* 551-571.

Poortinga, W., Bronstering, K., & Lannon, S. (2011). Awareness and perceptions of the risk exposure to indoor radon: A population-bases approach to evaluate a radon awareness and testing campaign in England and Wales. *Journal of Risk Analysis 31*(11) 1800-1812.

Portney, L. G., & Watkins, M. P. (2008). *Foundations of clinical research: applications to practice*. Prentice Hall, Upper Saddle River.

Powell, C. (2003) The Delphi technique: myths and realities. *Journal of Advanced Nursing 41* (4), 376-382.

Prislin, R., & Wood, W. (2005) *Social influence in attitudes and attitude change. The Handbook of Attitudes. Pp. 671–706.* Mahwah, NJ: Lawrence Erlbaum.

Prochaska, J.O., & DiClemente, C.C. (1983). Stages and processes of self-change of smoking: Toward an integrative model. *Journal of Consulting and Clinical Psychology* 390–395.

Pruss-Ustun, A., & Corvalan, C. (2006). Preventing disease through healthy environments: *Toward an estimate of the environmental burden of disease*. Geneva, Switzerland: World Health Organization. Retrieved November 26, 2008, from *http://www.who.int/quantifying_ehim pacts/publications/preventingdisease/en/index. Html*

Pruss-Ustun, A., & Corvalan, C. (2007). How much disease burden can be prevented by environmental interventions? *Epidemiology, 18,* 167–178.

Rakowski, W., Ehrich, B., Goldstein, M.G., Rimer, B.K., Pearlman, D.N., Clark, M.A., Velicer, W.F., & Woolverton, H. (1998). Increasing mammography among women aged 40–74 by use of a stage-matched, tailored intervention. *Preventive Medicine, 27,* 1–9.

Regan, D. T., & Fazio R. (1977). Consistency between attitudes and behavior: Look to method of attitude formation. *Journal of Experimental Social Psychology, 13* (1), 28–45.

Reif, A. E., & Heeren, T. (1999). Consensus on synergism between cigarette smoke and other environmental carcinogens in the causation of lung cancer. *Advances in cancer research, 76,* 161.

Rinker, G. H., Hahn, E. J., & Rayens, M. K. (2014). Residential radon testing intensions, perceived radon severity, and tobacco use. *Journal of environmental health, 76*(6), 42.

Rosenthal, S. (2011). Measuring knowledge of indoor environmental hazards. *Journal of Environmental Psychology, 31*(2), 137-146.

Samet, J. M., Zeger, S. I., Dominicini, F., Curriero, F., Coursac, I., Dockery, D. W., Zanobetti, A. (2000). The national morbidity, mortality and air pollution study, *Part II: Morbidity and mortality from air pollution in the United States (Research Report 94). Boston: Health Effects Institute.*

Sarkin, J. A., Johnson, S .S., Prochaska, J. O., & Prochaska, J. M. (2001). Applying the transtheoretical model to regular moderate exercise in an overweight population: Validation of a stages of change measure. *Preventive Medicine, 33,* 462– 469.

Schuman H., & Kalton G. (1985). *Survey methods. Handbook of Social Psychology. Pp. 635–698* New York: Random House.

Shendell, D, G., & Carr, M. (2013). Physical conditions of a house and their efforts on measured radon levels: data from Hillsborough Township, New Jersey, 2010-2011. *Journal of Environmental Health, 76*(3), 18.

Shlafer, R. J., McRee, A. L., Gower, A. L., & Bearinger, L. H. (2016). Better communication for better public health: perspectives from an interdisciplinary training program. *Health Promotion Practice.* 1524839915627453.

Simmons-Yon, A., Roth, M.T., Vu, M., Kavalieratos, D., Weinberger, M., & Rao, J.K. (2012). Understanding pharmacists' experiences with advice-giving in the community pharmacy setting: A focus group study. *Patient Education and Counseling, 89*(3), 476-483.

Spittal, M. J., McClure, J., Siegert, R. J., & Walkey, F. H. (2005). Optimistic bias in relation to preparedness for earthquakes. *Australasian Journal of Disaster and Trauma Studies,* 05, 1.

Tavakol, M., & Dennick, R. (2011). Making of Cronbach's Alpha. International Journal of Medical Education, 2, 53-55. http://doi.org/10.5116/ijme.4dfb.8dfb

Taylor, L., Miro, S., Bookbinder, S. H., & Slater, T. (2008). Innovative infrastructure in New Jersey: using health education professionals to inform and educate during a crisis. *Health Promotion Practice, 9*(4suppl), 88S-95S.

Terpstra, T., Lindell, M. & Gutteling, J. (2009.) Does communicating (flood) risk affect (flood) risk perceptions. *Risk Analysis,* (29) 8.

Tilson, H., & Gebbie, K. M. (2004). The public health workforce. *Annual Review of Public Health, 25,* 341-356.

Thompson, M. M., Zanna, M. P., & Griffin, D.W. (1995). *Attitude strength: Let's not be indifferent about (attitudinal) ambivalence. Antecedents and Consequences. Pp. 361–386* Mahwah, NJ: Lawrence Erlbaum.

Turner, M. C., Krewski, D., Chen, Y., Pope, C. A., Gapstur, S., & Thun, M. J. (2011). Radon and lung cancer in the American Cancer Society cohort. *Cancer Epidemiology Biomarkers & Prevention, 20*(3), 438-448.

Trasande, L., Boscarino, J., Graber, N., Falk, R., Schechter, C., Galvez, M.,……Landrigan, P. (2006). The environment in pediatric practice: A study of New York pediatricians' attitudes, beliefs, and practices towards children's environmental health. *Journal of Urban Health. 83* (4), 760-72.

Transande, L., Newman, N., Long, L., Howe, G., Kerwin, B.J., Martin, R. J., Gahagan, S. A. & Weil, W. B. (2010). Translating knowledge about environmental health to practitioners: are we doing enough?. *Mt. Sinai Journal of Med*. 77 (1), 114-23.

U.S. Department of Health, Education, and Welfare. (1979). Healthy people: *The Surgeon General's report on health promotion and disease prevention.* Retrieved October 26, 2012, from http://profiles.nlm.nih.gov/NN/B/B/G/K/_/nnbbgk.pdf

U.S. Department of Health and Human Services, Health Resources and Services Administration. (2000). *The public health work force enumeration.* Washington, DC: U. S. Government Printing Office.

U.S. Environmental Protection Agency. (2005). *Surgeon general's health advisory on radon.* Retrieved January 8th, 2015 from http://www.epa.gov/radon/healthrisks.html

U.S. Environmental Protection Agency. (2008). *More action needed to protect public from indoor radon risks. Office of Inspector General Report No. 08-P-0174 06/3/08* Retrieved January 8th, 2015, from http://www.epa.gov/oig/reports/2008/20080603-08-P-0174.pdf

U.S. Environmental Protection Agency. (2011). *Health indoor environment protocols for home energy upgrades. Office of Air and Radiation (6609J*) EPA 402/K- 11/003

U.S. Environmental Protection Agency. (2012). *A citizen's guide to radon*: EPA 402/K-12/002 Retrieved October 26th, 2012, from http://www.epa.gov/radon/pdfs/citizensguide.pdf

U.S. Environmental Protection Agency. (2014). Air quality index*: A guide to air quality and your health. EPA-456/F-14-002.* Retrieved August 26, 2016, from http://www3.epa.gov/airnow//aqi_brochure_02_14.pdf

Van Der Pligt, J., De Vries, N. K., Manstead, A. S. R., & Van Harreveld, F. (2000). The importance of being selective: Weighing the role of attribute importance in attitudinal judgment. *Advances in Experimental Social Psychology, 32,* 135-200.

Van Harreveld, F., & Van Der Pligt, J. (2004). Attitudes as stable and transparent constructions. *Journal of Experimental Social Psychology, 40*(5), 666–674.

Van Harreveld, F., Van Der Pligt, J., De Vries, N. K., Wenneker, C., & Verhue, D. (2004). Ambivalence and information integration in attitudinal judgment. *British Journal of Social Psychology, 43,* 431–447.

Visschers, V. H. M., Meertens, R. M., Passchier, W. F., & DeVries, N. K. (2007). How does the general public evaluate risk information? The impact of associations with other risks. *Risk Analysis, 27*(3), 715–727.

Wang, Y., Ju, C., Stark, A. D., & Teresi, N. (2000). Radon awareness, testing, and remediation survey among New York State residents. *Health Physics, 78*(6), 641-647.

Weinstein, N. D. (1980). Unrealistic optimism about future life events. *Journal of Personality and Social Psychology, 39*(5), 806.

Weinstein, N. D. (1989). Effects of personal experience on self-protective behavior. *Psychological Bulletin, 105*(1), 31–50.

Weinstein, N.D., Lyon, J.E., Sandman, P.M., & Cuite, C.L. (1998). Experimental evidence for stages of health behavior change: The precaution adoption process model applied to home radon testing. *Health Psychology, 17,* 445– 453.

Weinstein, N. D., & Sandman, P. M. (1992a). Predicting homeowners' mitigation responses to radon test data. *Journal of Social Issues, 48,* 63–83.

Weinstein, N.D., & Sandman, P.M. (1992b). A model of the precaution adoption process: Evidence from home radon testing. *Health Psychology, 11,* 170–180.

Weinstein, N. D., & Sandman, P. M. (2002). The Precaution Adoption Process Model and its application. *Emerging theories in health promotion practice and research. Jossey-Bass,* San Francisco, 16-39.

Weinstein, N. D., Sandman, P. M., & Blalock, S. J. (2008). The Precaution Adoption Process Model. *Health Behavior and Health Education. Jossey-Bass,* San Francisco, 123–147.

Weinstein, N. D., Sandman, P. M., & Roberts, N. E. (1991). Perceived susceptibility and self-protective behavior: a field experiment to encourage home radon testing. *Health Psychology, 10*(1), 25.

World Health Organization. (2002). *The world health report 2002*: *reducing risks, promoting healthy life.* World Health Organization.

World Health Organization. (2006). *Working together for health. World Health Report.* World Health Organization.

World Health Organization. (2007). *Cancer control: knowledge into action: WHO guide for effective programmes* (Vol. 2). World Health Organization.

World Health Organization. (2009). *WHO Handbook on indoor radon: a public health perspective*. World Health Organization.

White, M. P., Pahl, S., Buehner, M., & Haye, A. (2003). Trust in risky messages: The role of prior attitudes. Risk Analysis, 23 (4), 717–726.

APPENDIX A

Letter of Solicitation

LETTER OF SOLICITATION

Date: _____

Dear Public Health Worker,
My name is Paschal Nwako. I am a student at the School of Health and Medical Sciences at Seton Hall University. I am conducting this research study as part of my doctoral dissertation.

What is the purpose of the study?
You have been invited to participate in this study. You have been invited because you are a public health worker that presently works for a public health department. Available research has shown that the Indoor Radon Abatement Act (IRAA) is voluntarily regulated by the United States Environmental Protection Agency (USEPA). Reports have suggested the use of public health workers as change agents to disseminate information regarding radon hazards to the public to improve public awareness. The purpose of this study is to explore the knowledge, beliefs and practices of radon exposure among public health workers.

What is the study procedure?
You are being asked to consider participating in this study. This study might influence changes on how you as a public health worker can reach out to the public regarding communicating radon hazard. Completing the survey will take about 7 minutes. You can take as much time as you would like to complete this survey. The survey is available at
https://www.surveymonkey.com/r/radonassessment

Is participation voluntary?
Your participation in this research study is completely voluntary. You may decide not to participate at any time. By accepting and completing the survey, you acknowledge that you are providing your consent to participate in this research study. Camden County Health Department employees are excluded from participating in this study because principal investigator is affiliated with Camden County.

Is the survey anonymous?
This survey is completely anonymous as no identifying responses are requested. The research data may be published. If it is, it will not identify any individual.

What will happen to the study data? The study data will be kept confidential to protect its integrity. The data will be stored on a USB drive. The USB drive will be locked in a cabinet in the office of the principal investigator. The principal investigator, will have access to all of the data for a period of up to three years after the end of the study. After that time, the research data will be destroyed.

Thank you for considering participating and contributing to my dissertation research. Your time and consideration is greatly appreciated. By clicking on the link below and completing the study survey you acknowledge your informed consent to participate in the study. If you have any questions regarding this research or the process, please do not hesitate to contact the principal investigator Paschal Nwako at pn2@njlincs.net

The survey is available at

https://www.surveymonkey.com/r/radonassessment

APPENDIX B

Online Survey Instrument via Survey Monkey

General Knowledge about radon

Please provide your responses to the following questions about your knowledge of radon. All responses are anonymous.

* 1. Radon has a strong odor

TRUE	FALSE
○	○

* 2. Radon exposure is linked to lung cancer

TRUE	FALSE
○	○

* 3. Radon is a radioactive

TRUE	FALSE
○	○

* 4. Radon is invisible

TRUE	FALSE
○	○

* 5. Radon is a solid at room temperature

TRUE	FALSE
○	○

* 6. Radon is a gas at room temperature

TRUE	FALSE
○	○

* 7. Radon occurs naturally in rocks and soils

TRUE	FALSE
○	○

* 8. Radon levels are usually higher in the attic than the basement

TRUE	FALSE
○	○

* 9. About one in 15 homes in the United States have elevated radon levels

TRUE	FALSE
○	○

* 10. Being exposed to radon increases smokers chances of developing lung cancer

TRUE	FALSE
○	○

* 11. Radon is the leading cause of lung cancer in the United States among non-smokers

TRUE	FALSE
○	○

* 12. Testing for radon is the only way to determine if a home has an elevated radon level

TRUE	FALSE
○	○

Beliefs: Perceptions of Radon

Please provide your responses to the following questions about your perceptions of radon. All responses are anonymous.

* 13. Living with radon exposure greater than 4 picocuries per liter could result in serious health problems for me

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
○	○	○	○	○

* 14. I am worried about radon causing illness in me

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
○	○	○	○	○

* 15. There is a real chance that I could have a radon problem in my house

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
○	○	○	○	○

* 16. Mitigation of radon in my house can save lives

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
○	○	○	○	○

* 17. I believe that radon is likely to be present in homes in my neighborhood

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
○	○	○	○	○

* 18. I am worried about radon causing illness to the public that I serve

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
○	○	○	○	○

* 19. The health risk from the combination of smoking and radon is much greater than from either of these alone

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
○	○	○	○	○

* 20. If there is radon in my home, then it is a health risk to me

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
○	○	○	○	○

* 21. If there is radon in my home, then it is a health risk to others living with me

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
○	○	○	○	○

* 22. I believe that the health risk from the combination of second hand smoking and radon is much greater than from either of these alone

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
○	○	○	○	○

* 23. Reducing radon levels in homes helps prevent disease

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
○	○	○	○	○

* 24. I believe I have sufficient knowledge about radon to be a change agent in my community

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
○	○	○	○	○

Personal Practices:
What are your Personal Practices about testing for radon in your home?

Please provide your responses to the following questions about your personal practices of radon. All responses are anonymous

* 25. I know how to test for radon

YES	NO
○	○

* 26. I have purchased a radon test kit

YES	NO
○	○

* 27. I plan to perform a radon test in my home

YES	NO
○	○

* 28. I have completed a radon test in my home

YES	NO
○	○

29. If yes, how many times within the last 3 years have you tested your home for radon?

One	Two	Three or more	N/A
○	○	○	○

Professional Practices
What are your Professional Practices of educating the public about radon?

Please provide your responses to the following questions about your professional practices of educating the public about radon as part of your job. All responses are anonymous.

* 30. I have informed members of the public about the hazards of radon

YES	NO
○	○

31. If yes, how many times within the past 12 months have you informed members of the public about the hazards of radon?

One	Two	Three	Four	Five or more	N/A
○	○	○	○	○	○

* 32. I have urged members of the public to test their homes for radon

YES	NO
○	○

33. If yes, how many times within the past 12 months have you urged members of the public to test their homes for radon?

One	Two	Three	Four	Five of more	N/A
○	○	○	○	○	○

* 34. I have informed the public about the combined effect of smoking and radon exposure

YES	NO
○	○

35. If yes, how many times within the past 12 months have you informed members of the public about the combined effect of smoking and radon exposure?

One	Two	Three	Four	Five or more	N/A
○	○	○	○	○	○

* 36. I have urged members of the public to inform their family about radon

YES	NO
○	○

37. If yes, how many times within the past 12 months have you urged members of the public to inform their family about radon?

One	Two	Three	Four	Five or more	N/A
○	○	○	○	○	○

38. Please provide any input you may have regarding radon knowledge, belief, personal and professional practices.

Demographics

Please provide information regarding your job, education, smoking status and residence. All responses are anonymous.

* 39. Please Provide your Public Health Job Title or select the title that best describes your job

* 40. How many years have you worked in your field

* 41. Please provide your current age

* 42. Please select your gender

* 43. Education: Please select your highest completed level of education

* 44. Are you a current cigarette smoker?

YES	NO
○	○

* 45. Are you a former smoker?

YES	NO
○	○

* 46. Have you smoked at least 200 cigarettes in your life?

YES	NO
○	○

* 47. Do you now smoke cigarette?

Everyday	Some days	Not at all
○	○	○

* 48. Do you own the residence where you live?

YES	NO
○	○

* 49. Do you rent where you live?

YES	NO
○	○

* 50. How many years have you lived in your current residence

APPENDIX C

Body of Email to the Health Alert Network Coordinator

BODY OF EMAIL TO HEALTH ALERT NETWORK COORIDINATOR:

Dear Health Alert Network Coordinator:

I am sending this email with its attached letter of solicitation for you to further disseminate via New Jersey Literacy Information and Communication System Portal (NJLINCS) to all public health workers. I am conducting a survey on Radon. This survey research might influence the way public health workers communicate radon hazards to the public. This survey takes approximately 7 mins to complete.

The attached letter of solicitation explains the purpose of the study, study procedure, voluntary nature of the survey, anonymity of the survey, confidentially of the data, benefit of participating and requests for further information. The letter of solicitation also has a link to Survey Monkey where public health workers can click to access the survey instrument. That link is

https://www.surveymonkey.com/r/radonassessment

I highly appreciate your effort in disseminating the letter of solicitation to all public health workers.

Sincerely

Paschal Nwako

APPENDIX D

Permission to use Health Alert Network in disseminating Letter of Solicitation

Re: Survey Questionnaire

Ross Ninger

Mon 12/21/2015 4:06 PM

To:Paschal Nwako <pn2@njlincs.net>;

Cc:Ross Ninger <rsn1@njlincs.net>;

Paschal

I have reviewed the survey. It is fine to be sent out to our audience as an attachment in a Public Heath Message created by you.

Ross

Ross S. Ninger
NJ Department of Health
PHILEP Division

From: Paschal Nwako
Sent: Monday, December 21, 2015 3:42 PM
To: Ross Ninger
Subject: Re: Survey Questionnaire

Ross,

See attached the radon survey proposal. I need approval from you that the survey can be sent out to public health workers through NJLINCS when my proposal is approved.

Thanks

Paschal Nwako

From: Ross Ninger
Sent: Wednesday, December 16, 2015 4:40 PM
To: Paschal Nwako
Subject: Re: Survey Questionnaire

Paschal

We can send this out over LINCS Public Health Massaging System. If you enter the specifics in the Message Creation Section of the system, we will arrange to approve and send it.

Regards

Ross

Ross S. Ninger
NJ Department of Health
PHILEP Division

From: Paschal Nwako
Sent: Wednesday, December 16, 2015 3:45 PM
To: Ross Ninger
Subject: Survey Questionnaire

Dear Ross,

My name is Paschal Nwako. I am the Camden County Health Officer. I am performing a survey Exploring the Knowledge, Beliefs and Practices of Radon gas exposure among public health workers. I am writing to ask for permission to send a letter to all HAN users with a link to *survey monkey* asking them to voluntarily participate in the survey. This study might determine how public health workers regulate radon.

I can be reached at 856 3746037 if you need to discuss with me. I also have a copy of the survey proposal and a link to the 5 min questionnaire on survey monkey.

Thanks

Paschal Nwako

APPENDIX E

Work Authorization to Conduct Research

Board of
Chosen Freeholders

Carmen G. Rodriguez
Freeholder

camden county

Making It Better, Together.

www.camdencounty.com

Courthouse, 12th Floor
520 Market Street
Camden, New Jersey 08102-1375
phone 856.225.5575
fax 856.225.5336
carmenr@camdencounty.com

October 5, 2015

Seton Hall University
Institutional Review Board
400 S. Orange Ave.
South Orange, NJ 07079

To whom it may concern,

Paschal Nwako is the Camden County Health Officer and the Public Health Coordinator. He is presently working on a doctorate degree (PhD) in Health Sciences from Seton Hall University. Paschal is engaged in the dissertation process towards fulfillment for the doctorate degree program. His dissertation work is on radon knowledge, beliefs and practices among public health workers. The dissertation process, regardless of the topic, requires approval from an Institutional Review Board (IRB).

Presently, the Camden County Department of Health and Human Services does not have an Institutional Review Board, hence this letter to that effect. Paschal is free to seek Institutional Review Board approval with Seton Hall University to fulfil the requirements needed to complete his dissertation work.

Sincerely,

Carmen G. Rodriguez
Freeholder Liaison
Camden County Department of Health and Human Services

APPENDIX F

Seton Hall IRB Approval Letter

OFFICE OF INSTITUTIONAL
REVIEW BOARD
SETON HALL UNIVERSITY

May 4, 2016

Paschal Nwako

Dear Mr. Nwako,

The Seton Hall University Institutional Review Board has reviewed the information you have submitted addressing the concerns for your proposal entitled "Exploring Knowledge, Beliefs, and Practices of Radon Gas Exposure among Public Health Workers." Your research protocol is hereby accepted as revised and is categorized as exempt.

Please note that, where applicable, subjects must sign and must be given a copy of the Seton Hall University current stamped Letter of Solicitation or Consent Form before the subjects' participation. All data, as well as the investigator's copies of the signed Consent Forms, must be retained by the principal investigator for a period of at least three years following the termination of the project.

Should you wish to make changes to the IRB approved procedures, the following materials must be submitted for IRB review and be approved by the IRB prior to being instituted:

- Description of proposed revisions;
- *If applicable*, any new or revised materials, such as recruitment fliers, letters to subjects, or consent documents; and
- *If applicable*, updated letters of approval from cooperating institutions and IRBs.

At the present time, there is no need for further action on your part with the IRB.

In harmony with federal regulations, none of the investigators or research staff involved in the study took part in the final decision.

Sincerely,

Mary F. Ruzicka, Ph.D.

Mary F. Ruzicka, Ph.D.
Professor
Director, Institutional Review Board

REQUEST FOR APPROVAL OF RESEARCH, DEMONSTRATION OR RELATED ACTIVITIES INVOLVING HUMAN SUBJECTS

All material must be typed.

PROJECT TITLE: Exploring Knowledge, Beliefs and Practices of Radon gas exposure among Public Health Workers.

CERTIFICATION STATEMENT:

In making **this application,** I(we) certify that I(we) have read and understand the University's policies and procedures governing research, development, and related activities involving human subjects. I (we) shall comply with the letter and spirit of those policies. I(we) further acknowledge my(our) obligation to (1) obtain written approval of significant deviations from the originally-approved protocol BEFORE making those deviations, and (2) report immediately all adverse effects of the study on the subjects to the Director of the Institutional Review Board, Seton Hall University, South Orange, NJ 07079.

Paschal Nwako — April 5th, 2016
RESEARCHER(S) — DATE

Please print or type out names of **all researchers below signature.
Use separate sheet of paper, if necessary.**

My signature indicates that I have reviewed the attached materials of my student advisee and consider them to meet IRB standards.

Terrence F. Cahill, EdD, FACHE — 4/6/16
RESEARCHER'S FACULTY ADVISOR [for student researchers only] — DATE

Please print or type out name below signature

The request for approval submitted by the above researcher(s) was considered by the IRB for Research Involving Human Subjects Research at the April 2016 meeting.

The application was approved ✓ not approved ___ by the Committee. Special conditions were ___ were not ✓ set by the IRB. (Any special conditions are described on the reverse side.)

Mary J. Ruzicka, Ph.D. — 5/4/16
DIRECTOR, — DATE
SETON HALL UNIVERSITY INSTITUTIONAL
REVIEW BOARD FOR HUMAN SUBJECTS RESEARCH